

RESEARCH PROJECT

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# VALUE ENGINEERING

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# Introduction

Packaging plays an essential role in safeguarding industrial equipments during transportation and storage. Groz Engineering Tools Pvt. Ltd. (Groz Tools) is an Indian manufacturing company known for its lubrication products, pumps, hand tools, and heavy-duty equipment. The company exports these products to over 80 countries worldwide. The export process involves multiple steps. Initially, goods are shipped via sea freight. This process includes several handovers until the products reach the importer or distributor in the destination country. These importers or distributors then sell the products to retailers, who ultimately sell them to the end customers, usually industrial businesses.

Groz's Oil Hose Reel is a relatively heavy product that requires sturdy yet cost-effective packaging. With its current corrugated packaging, Groz Tools has experienced about 18% product damage, resulting in additional costs to replace the damaged product and customer dissatisfaction. This research aims to identify, test, and implement an alternative packaging solution to the corrugated packaging (inner packaging) currently used by Groz Tools for its Oil Hose Reels.

The findings of this study could be used for packaging of other products with similar specifications.

## **The goal will be reached if:**

1. I can determine alternative packaging options through secondary research.
2. I can test the alternative for the specified product.
3. I can identify the optimal packaging solution, which helps enhance the product's value by lowering costs and eliminating damage.

# Objectives

1. Identify issues with current packaging
2. Determine needs for the new packaging
3. Research different packaging options
4. Test various packaging methods based on research & testing.
5. Recommend an efficient packaging type.

# Purpose

This project is highly valuable because it can help Groz Tools lower packaging costs and eliminate product damage to its Oil Hose Reel, leading to increased customer satisfaction and a stronger competitive edge.

Additionally, this can help them explore this new packaging as an alternative solution for their other heavy duty products.

It can also promote industry-wide packaging sustainability, resulting in significant improvements in the overall industry's environmental impact. I believe this is particularly important because conserving resources for future generations while meeting current demands is crucial, and this can only be achieved through growth in an industry's sustainability.

# Approach

## **To achieve my aim, I will use the following approach:**

1. Identify issues with current packaging.
2. Determine factors causing these issues.
3. Research different types of packaging that can help reduce or eliminate these problem areas.
4. Test each packaging option with its suitable design.
5. Through repeated trials, draw relevant conclusions and identify the best possible packaging solution.

An alternate approach was to change the outer packaging material in order to increase the strength and durability of the overall packaging. This would reduce the compression load to the inner packaging material. However, this was rejected due to higher cost of overall packaging.

This method is used because it lets me research online for potential packaging options before placing a trial order. Working with a tool manufacturing company is highly advantageous, as they have access to a wide range of packaging solutions. Additionally, they possess industry-standard packaging testing equipment, enabling me to properly evaluate each packaging option.

## Plan

**My plan for the entire project was divided into three main parts:**

1. Research
2. Testing & its Analysis
3. Costing & its Analysis

Since I was working with the General Manager, from the company itself, I had easy access to various packaging solutions. The material analysis relied heavily on research; therefore, I set aside an extra week to research and identify different types of packaging options. Since I had limited knowledge of the product's requirements and packaging fundamentals, I dedicated the first two days to understand the product, its needs, key impact areas, and the common damage points with regards to the current design.

After a week of research, I allocated 2 weeks to test and analyse my project's results. The extra time was also allocated to include potential delivery delays.

| <b>Total Time: 3 Weeks</b> |   |
|----------------------------|---|
| <b>DAY</b>                 | <b>SCHEDULE</b>   |
| <b>WEEK 1</b>              |   |
| Day 1 - Day 2              | Understanding basic needs from the packaging, current packaging and its flaws |
| Day 3 - Day 6              | Research: Packaging material types & their availability                       |
| <b>WEEK 2</b>              |   |
| Day 1                      | Placing sample order for the selected packaging materials                     |
| Day 2 - Day 3              | Delivery & Testing of Molded Pulp Trays                                       |
| Day 4 - Day 5              | Delivery and Testing of Paper Honeycomb Panels                                |
| Day 6                      | Scheduled Maintenance of Testing Equipment                                    |
| <b>WEEK 3</b>              |   |
| Day 1 - Day 3              | Delivery and Testing of EPE foam inserts                                      |
| Day 4 - Day 6              | Concluding project based on research, testing and findings                    |

## Current Packaging Analysis

The current inner packaging used by Groz Tools is corrugated packaging. It consists of using 5-ply cardboard to protect the hose reel. The layout includes 3 interlocked pieces of cardboard as shown in the image (right).

The multi-compartment structure immobilizes the hose reel, but adds weight and may under perform during heavy impact or stacking.

Current Packaging Weight: 28.58 kg





Inside of Box



Bent Rim of Hose Reel



Condition of inner corrugation packaging

| Packaging Material         | Load Capacity                   | Weight   | Cost                           | Environmental Factor | Other Notes           |
|----------------------------|---------------------------------|----------|--------------------------------|----------------------|-----------------------|
| 5 Ply Corrugated Cardboard | Moderate Upto 180 lbs. (82 kgs) | Moderate | Moderately High (Rs. 224.4/kg) | Fully Recyclable     | Sensitive to Moisture |

## RESEARCH

### Molded Pulp Trays

Molded Pulp Packaging is a type of packaging made from various fibrous materials such as recycled paper, cardboard offcuts, and natural fibers.

#### Structure & Strength:

The structure of pulp trays often includes a dimpled design that helps dissipate impact, providing good shock absorption. However, its resistance to compression is only moderate. While they are rigid enough to distribute the load across their surface, they are not dense enough to withstand extreme forces like other solutions can handle.

#### Weight:

It is moderately heavy due to its moderate density compared to that of foam (low density) and thick corrugated boards (high density).

#### Cost:

It features a simple manufacturing process and utilizes inexpensive raw materials like recycled fibers.



**Production Process:**

Its production process is a drawback because it is considerably slower than that of corrugated packaging. This is due to steps such as de-watering and drying, which require more time per unit, resulting in higher costs. In terms of assembly, it is quite efficient because pulp pieces are rigid and singular.

**Sustainability:**

The packaging process is highly sustainable because it uses recycled fibers and paper. Using sustainable raw materials helps reduce carbon emissions and waste during the packaging process, which lowers costs and appeals to environmentally conscious consumers.

Currently, it is used in the heavy tooling industry for products like power tools. Therefore, it could serve as a suitable alternative to corrugated packaging.

## EPE Foam Inserts

EPE Foam Inserts or Expanded Polyethylene lightweight packaging tools are commonly used as cushioning inserts.

**Structure & Strength:**

They are a type of closed-cell foam, which means they have uniform, interlocking cells that are sealed, making them highly rigid and durable. When impacted, the bubbles distribute the force throughout the structure, providing good shock absorption and protecting the product. However, the foam remains soft and compressible, so under heavy loads, it may flatten out, reducing its protective capability due to decreased thickness. Additionally, it offers limited structural support because of its flexibility. Therefore, to use it effectively, it should ideally be paired with something like a crate.

**Weight:**

It has an approximate density between 20 and 120 kg/m<sup>3</sup>, making it a very lightweight packaging material and helping to reduce shipment costs.

**Cost:**

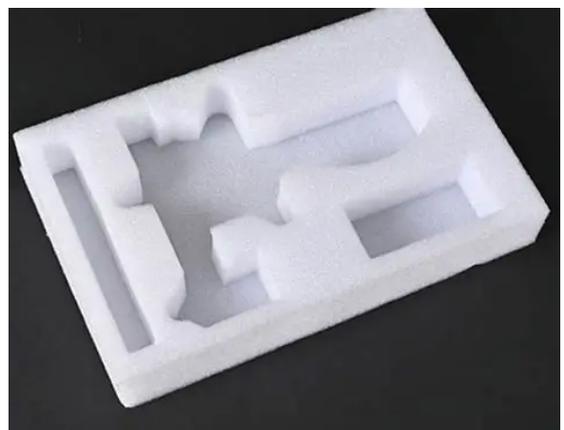
The need for support in addition to the EPE foam itself makes it a relatively expensive packaging method. This type of foam also doesn't stack, which means it takes up a lot of space and increases storage costs.

**Production Process:**

It can be mass-produced because polymer beads can be expanded and cut quickly, allowing for high efficiency and lower costs. Assembling these inserts mainly involves placing them, which is a relatively fast process.

**Sustainability:**

As a poly-olefin, it is completely recyclable and therefore a sustainable packaging option.



# Honeycomb Structures

Honeycomb packaging is a lightweight yet strong material made by bonding layers of Kraft paper into a hexagonal cell structure, similar to a honeycomb.

## Structure & Strength:

This design features a hexagonal cell geometry that evenly distributes load across its surface. It offers high impact resistance because the structure can quickly deform and collapse upon impact, absorbing the energy from the movement of the box or product. Additionally, it has very high compression strength because all its hexagonal cells are interconnected, sharing the full load of the product rather than concentrating stress at a single point. Its strength is so impressive that it can support up to 295 kg, compared to only 82 kg for standard corrugated packaging.

## Weight:

The honeycomb packaging has a very low density of about 30-50 kg/m<sup>3</sup>. This makes it a very lightweight option, decreasing the weight of the package and consequently reducing costs.

## Cost:

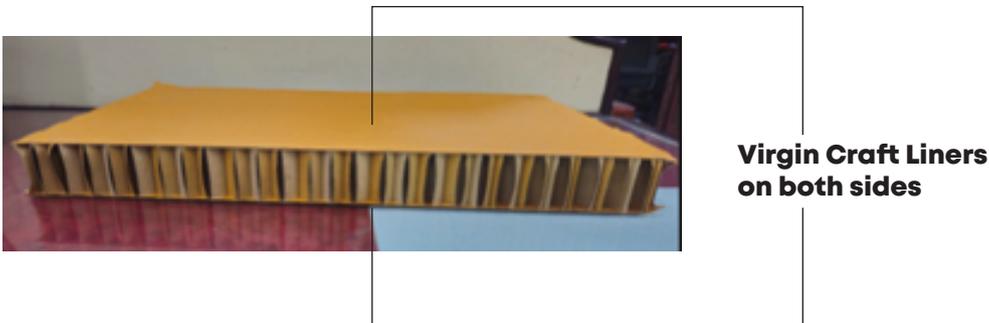
Their main raw material is paper fibers, which are relatively inexpensive. Compared to corrugated packaging, it has fewer layers to assemble, resulting in a faster packaging process and lower average costs due to higher efficiency.

## Production Process:

In terms of tooling, it is produced in a similar way to corrugated cardboard, so they have roughly the same tooling costs.

## Sustainability:

Since it's made from paper fibers, it is completely recyclable, which makes it sustainable.



## Comparison

In terms of overall damage protection, the load capacities of molded pulp trays, EPE foam inserts, and honeycomb packaging are 250, 90, and 295 kg, respectively. This shows that honeycomb packaging has the strongest overall compression strength.

Regarding impact resistance, molded pulp trays have a dimpled structure that provides good impact resistance. EPE foam inserts consist of closed foam cells with interlocking structures, giving them extremely good impact resistance. Honeycomb packaging has a hexagonal geometry that allows impacts to be distributed throughout the structure, resulting in very good impact resistance. In impact resistance, EPE foam inserts are likely the best, just slightly surpassing honeycomb packaging. However, when considering overall damage protection, due to its excellent load capacity and nearly top-tier impact resistance, honeycomb packaging is the most effective of the three.

In terms of overall cost, molded pulp trays are the cheapest option due to their low material cost. Although they require higher tooling expenses, the low material costs compensate for this. The next most affordable solution is honeycomb packaging, mainly because of its higher material costs. The most expensive of the three are EPE Foam Inserts, which have significantly higher material costs than the other two. Even their lower labor costs do not make up for the higher material expenses, resulting in a higher overall cost.

Regarding sustainability, molded pulp trays, made entirely from recycled paper, are the most sustainable. Honeycomb packaging, made from Kraft paper, is a close second, as its material is 100% bio-degradable, contributing to high sustainability levels. In contrast, EPE Foam Inserts are petroleum-based plastics, which are not bio-degradable, leading to lower sustainability.

## TESTING

For the 3 selected alternative solutions, I chose to conduct two key tests:

1. Drop test
2. Vibration test

These tests were specifically selected for this scenario.

### Drop Test

It is commonly seen that packages are often dropped during handling, loading, and delivery process. This frequently causes significant damage to the products, resulting in additional business costs due to returns and replacements. Furthermore, due to the product's heavy weight, these drops can cause additional damage, making it crucial to test whether the chosen packaging can withstand drops.

For the three packaging solutions, I conducted a drop test from a height of 46cm, as it is the most realistic height. A height of 40cm to 50cm typically matches the waist-to-knee ratio from which products are often dropped. Additionally, this height allows for assessing the effectiveness of the packaging without risking damage to the products during testing, which could lead to unnecessary expense for the business.

Conducting a test that mirrors real-life scenarios is important because it helps simulate actual conditions, ultimately aiding in cost reduction. A total of three trials were performed for this test.



## Vibration Test

During long journeys such as long-distance shipping, products are subjected to repeated vibrations caused by vehicle movement. This can damage packaging and potentially harm the product itself, leading to unnecessary costs for the business.

For this specific test, I used the vibration simulator at Groz. This helped replicate real-life scenarios that might happen when the product is transported over long distances. **The displacement produced by the machine was 25.4mm.** The frequency was adjusted so that the packaged box begins to “bounce” without actually falling over. Additionally, this process was carried out for 1 hour. A total of 3 trials were performed for this test.



## TESTING ANALYSIS

Both tests were performed on each packaging solution and the results were as follows:

### Drop Test

#### Packaging using Molded Pulp Trays

| Component         | Damage Observed | Type of Damage  |
|-------------------|-----------------|-----------------|
| Box               | No              | Negligible      |
| Molded Pulp Trays | Yes             | Crushed Surface |
| Product           | Yes             | Deep Dents      |

#### Packaging using EPE Foam Inserts

| Component        | Damage Observed | Type of Damage |
|------------------|-----------------|----------------|
| Box              | No              | Negligible     |
| EPE Foam Inserts | Yes             | Minor Cracks   |
| Product          | Yes             | Minor Dents    |

#### Packaging using Honeycomb Panels

| Component        | Damage Observed | Type of Damage |
|------------------|-----------------|----------------|
| Box              | No              | Negligible     |
| Honeycomb Panels | Yes             | Minor Cracks   |
| Product          | No              | None           |

# Vibration Test

| Packaging Material | Visible Damage to Packaging | Status for Test |
|--------------------|-----------------------------|-----------------|
| Molded Pulp Trays  | Visible Cracks              | Fail            |
| EPE Foam Inserts   | None                        | Pass            |
| Honeycomb Panels   | None                        | Pass            |

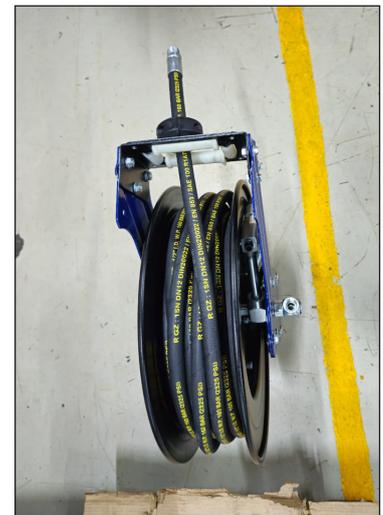
## Packaging Condition after testing Honeycomb Panels



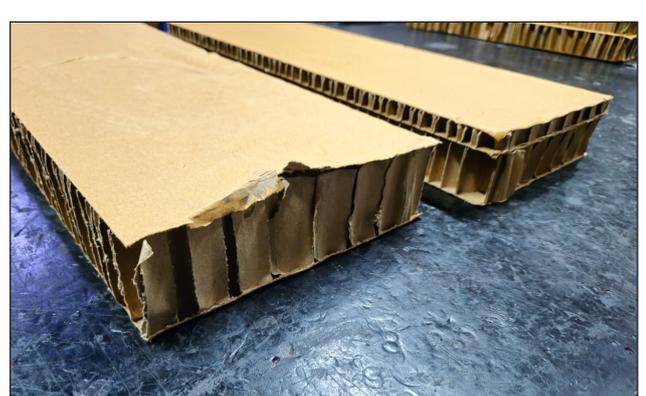
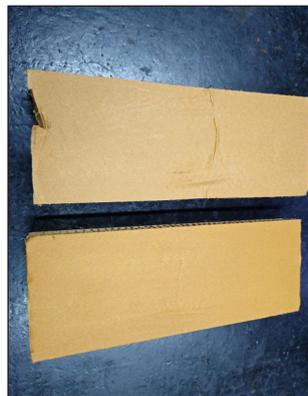
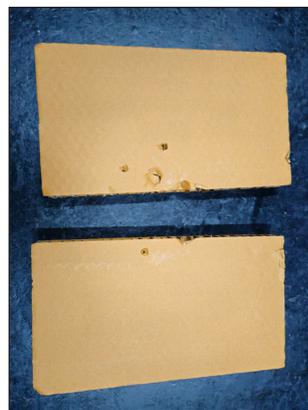
Inside of Box



Product Condition



Condition of outer corrugated packaging



Condition of Honeycomb Panels after testing

# TESTING RESULTS

Based on the two tests conducted, I reached the following conclusions:

**Honeycomb Packaging clearly outperformed Molded Pump Trays & EPE Foam Inserts.**

During the drop test, it was observed that there was visibly no damage to the product in the case of Honeycomb Panel insert packaging. This is likely due to its hexagonal cell design, which allowed the product to absorb impact and distribute it over a larger area, providing better protection.

During the vibration test, both EPE Foam Inserts and Honeycomb Packaging were equally effective at protecting the product. The Honeycomb structure kept its rigidity because of its hexagonal cell design, while the EPE Foam Inserts used their interlocking cells to stay rigid and prevent damage to the product.

Overall, because Honeycomb panels performed the best in the drop test and matched the top performance in the vibration test, Honeycomb Packaging is the best possible packaging solution for Oil Hose Reels.

## COSTING ANALYSIS WITH HONEYCOMB PACKAGING

| Item                 | Old Packaging (Rs. / kg) | New Packaging (Rs. / kg) | Remarks                       |
|----------------------|--------------------------|--------------------------|-------------------------------|
| Outer Corrugated Box | 135.9                    | 135.9                    | Unchanged                     |
| Sticker              | 31.05                    | 31.05                    | Unchanged                     |
| Instruction Manual   | 3.87                     | 3.87                     | Unchanged                     |
| Corrugated Packing   | 224.4                    | -                        | Replaced in new design        |
| Honeycomb Packing    | -                        | 105.8                    | Cost-effective and protective |

| Overall Packaging Cost |                   |
|------------------------|-------------------|
| Old Packaging Cost     | Rs. 395.22        |
| New Packaging Cost     | Rs. 276.62        |
| <b>Cost Saving</b>     | <b>Rs. 118.67</b> |

- **Additionally, the packaging re-design reduces the fully packaged product weight by approximately 12%, from 28.58 kg to 25.12 kg.**
- This weight reduction translates to **lower transportation costs and easier handling.**
- Honeycomb packing provides superior load support and cushioning compared to heavier corrugated packing.
- Honeycomb reduces assembly errors compared to complex corrugated box leading to increased packaging speed.

## CONCLUSION

- **The packaging redesign project concludes that Honeycomb Packing offers a superior balance of protection, weight reduction, and sustainability for the Groz Oil Hose Reel.**
- **This solution reduces packaging weight by 3.46 kg, improving logistical efficiency while maintaining cost-effectiveness and enhancing product safety.**

# EVALUATION

**After completing the project, I feel there are a few areas that could have been improved:**

1. Cost analysis was done for only 1 unit of packaging. A bulk costing would have further reduced overall cost leading to greater cost saving.
2. Both the vibration and drop tests were conducted only three times. Repeating these tests more number of times could have provided a better understanding of the actual damage to the product with each respective solution.
3. Also I could look at different design iterations for the outer packaging, but not in silos. I would have to see how the change would impact handling of the box versus the cost.

## CHALLENGES I FACED

At first, I worried that honeycomb looked “weaker” than thick corrugated dividers, but lab tests and my own drop tests proved otherwise. Learning to interpret data sheets, run cost analyses, and get hands-on with prototype packaging were key professional growth moments for me.

I learned that even small design changes—like swapping divider material—require balancing. Working with a supportive mentor and being trusted with real responsibility was the highlight of my research project so far.

## ACKNOWLEDGEMENTS

I sincerely thank Groz Engineering Tools Pvt. Ltd. for providing me with this research opportunity and invaluable exposure to industrial packaging design.

Special thanks to my internship mentor (Mr. Sunil Verma, General Manager, Design & Development) for his continuous guidance and support.

I also appreciate the Packaging and Design team at Groz for their technical assistance and encouragement during the project.

## SOURCES

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