Vellore Institute of Technology
(Deemed to be University under section 3 of UGC Act, 1956)

PROJECT REPORT

SUBJECT CODE: **MEE3502**

SUBJECT NAME: **DESIGN PROCESS PLANNING AND MANAGEMENT**

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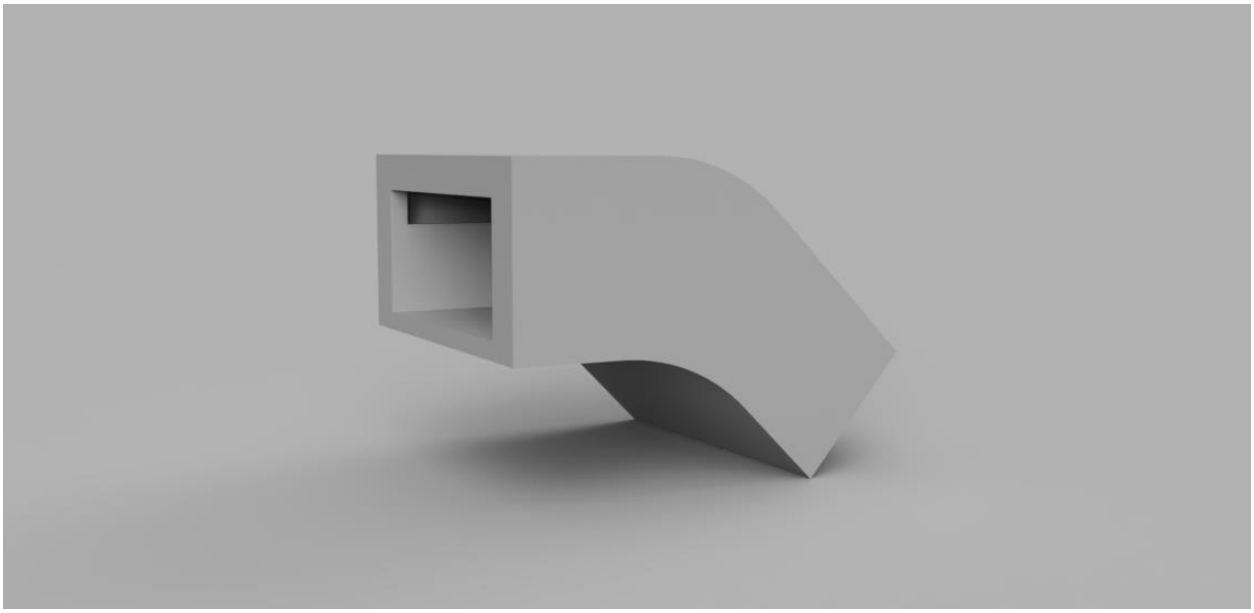
Submitted to

ANANDAVEL K



Efficient Cleaning and Storage Solutions: Fan Blade Cleaner with Waste-Compacting Technology

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DESIGN PROCESS PLANNING AND MANAGEMENT

1.ABSTRACT

This report aims to address the health risks associated with the accumulation of dust in fans and the tedious process of cleaning them. The traditional method of cleaning fans using towels and water results in further cleaning and wastage of water, while the use of a ladder or chair during the cleaning process poses a risk of falling. To solve these issues, the report proposes a fan cleaner and waste compactor that are user-friendly, easy-to-use, and safe to use. The products are expected to benefit households, large companies, schools, colleges, hotels, and other large organizations, providing a convenient solution for removing dust from fans and storing the waste in a compact and organized manner, thus improving air quality and saving storage space.

The fan cleaner is designed to clear dust that has accumulated on fan wings, which can cause respiratory problems such as coughing, sneezing, and asthma. The waste compactor promotes the Indian government's Swachh Bharat Abhiyan effort, with a slider that may be pressed to compress the garbage and increase the amount of room inside the bin, reducing littering, and promoting a cleaner and greener environment.

Overall, these two items have the potential to assist a wide spectrum of customers, including households, schools, offices, and public spaces, improving respiratory health, promoting cleanliness and environmental sustainability, and contributing to sustainable development and public health. The report aims to ensure that the cleaning process does not result in dust leakage and damage to the fans, prioritizing the safety of the users.

2. INTRODUCTION

2.1) BACKGROUND WORK

Two key elements were developed during the idea development of our vacuum with a fan cleaner module, a tool for more effectively and easily cleaning fan blades, and a compactor for gathering and controlling dust and waste.

A holder or collector, two cleaning brushes attached to a sliding handle with a comfortable and ergonomic design, and tiny screws used to secure the brushes to the holder and handle make up the fan cleaner tool. One cleaning brush is attached to the holder's top body to clean the fan blade's top side, while the other is connected to the sliding handle to clean the blade's bottom.

This can be used by attaching the ceiling fan blade between the two brushes and sliding the tool along the blade to clean it while standing on the floor. a compactor that can gather and compress the dust and debris gathered by the vacuum cleaner with fan cleaner module in order to address the problem of dust and debris collection and management. With the help of slider that is attached to it will make compressing the dust simpler and easier to collect and manage the waste as a result of the reduction in waste volume. By minimizing the quantity of trash and debris that collects around the trash cans, the compactor will also increase the cleanliness of the surrounding area.

2.2) LITERATURE SURVEY

Ceiling fan is a common thing in every house, college, office, restaurants and so on for cooling purpose. Naturally dust gets settled in these fan wings. So, several attempts have been made to eliminate the problem of cleaning fans.

[1] In a study conducted by Chen et al. (2018), the authors tested the cleaning performance of a handheld fan cleaner and a fan cleaning attachment using a controlled experiment. They found that both devices were effective in removing dust and debris from fan blades, but the fan cleaning attachment was more efficient and less time-consuming than the handheld fan cleaner.

[2] In a study conducted by Liao et al. (2019), the authors developed a fan cleaning wand with a flexible hose that could reach even the most hard-to-reach fan blades. The wand was found to be effective in removing dust and debris from fan blades and was preferred by users over traditional cleaning methods.

[3] (Chew, Thye Hin) created a ceiling fan cleaner with rotatable roller for cleaning. The breadth of the roller cleaner is equal to the typical width of a ceiling fan blade. The system collects the dust from the fan by pulley's fixedly attached to one end roller and handle, and when the first pulley is rotated like a fishing stick, the pulley attached to the roller cleaner rotates equally as well. Due to rotation of the roller cleaner the tool cleans the dust.

[4] (Nicholson, Roy V) built a fan cleaning apparatus that has a bent wire brush with a dustpan carried below the brush by a rod.

[5] (Corsetti, John A) constructed a device to simultaneously clean the top and bottom surfaces of a fan blade with a single movement of the cleaning device. That has a Y-Shaped fork attached with a hollow rectangular cleaning cloth. The cleaning cloth is inserted between the fan blades and wipes out the dust simultaneously on both sides.

[6] (Kunes, Jeffrey) invented A vacuum attachment nozzle that is specifically designed to be quickly attached to almost any household vacuum and is included in a system for cleaning ceiling fan blades. The apparatus is made specifically to simultaneously and effectively remove dust from

all surfaces of a ceiling fan blade. Managing waste is itself a huge task and many attempts have been made to solve this problem.

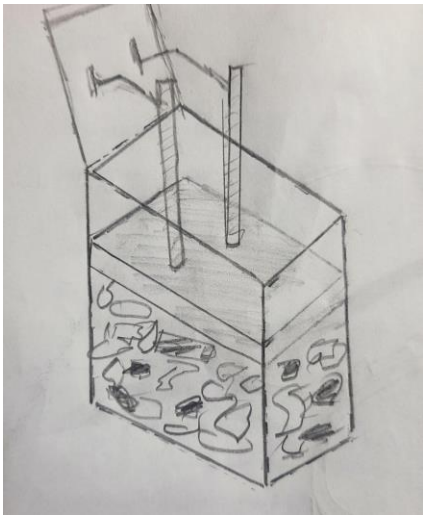
3. CONCEPT GENERATION

In this project, our focus was to address the common problems faced by individuals, such as young urban professionals or those with busy schedules, in cleaning fans. We conducted internal research by executing surveys, asking peers, and testing our prototypes to evaluate the effectiveness of the solutions provided. We then searched external sources to review existing product concepts and patents to identify areas of innovation and changes that we could incorporate into our design concept. We developed several prototypes based on our problem statements and evaluated them based on their performance factors and efficient design. We recorded our conclusions in a ranking matrix. After observing all the problem statements, we listed out the end features that would be included in the final concept. Overall, our goal was to provide individuals with a convenient cleaning solution that would reduce their difficulties in cleaning fans. By conducting thorough research, designing and evaluating prototypes, and finalizing end features, we aimed to create an innovative product that would meet the needs of our customers.

4. SELECTION OF CONCEPTS

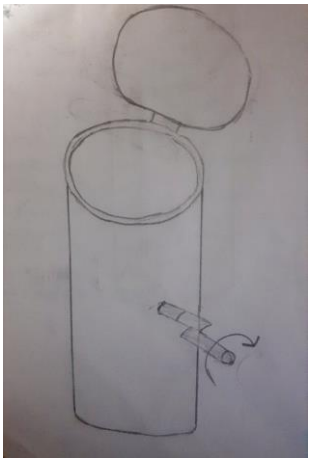
Prototype 1:

Our first concept consisted of a simple dustbin with a compactor. With the help of compactors, we can increase the storage space. In this prototype the two metal rods are attached to the lever which is fixed in the bottom of lid. When we need to compress the dust with the help of those two metal rods as shown in the figure, we can compress the dust. Since this process is complicated and not effective, we rejected this prototype



Prototype 2:

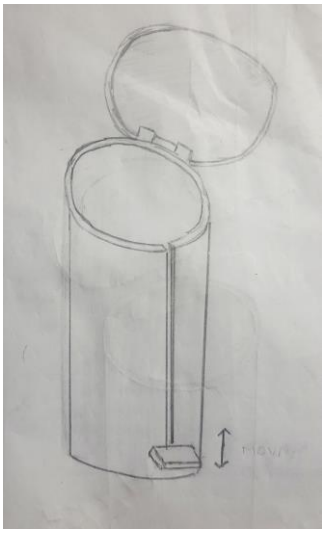
In the second prototype we made some compactor changes like we built a mechanism when we rotate the handle it compressed. In this prototype we have made it use a lever mechanism, basically when we operate the lever it will lift the lid up compressing the waste stored inside it. This essentially increases the duration with which the plastic bags can be used to save space.



Prototype-3

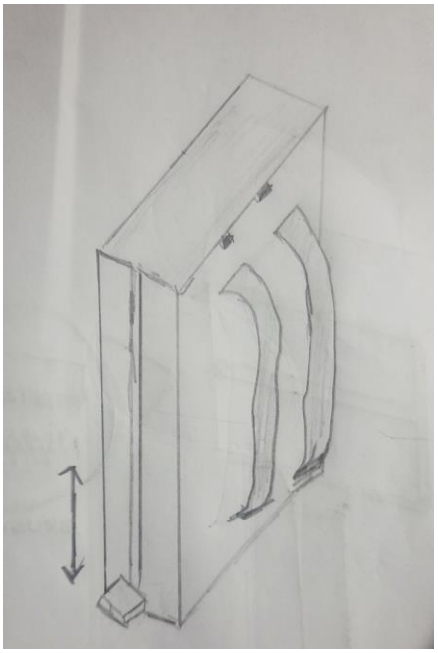
In the third prototype we again modified the compactor design so that it increases the storage space and helps to compress the dust easier than the above mentioned two mechanisms. This is a prototype which has the same purpose as the above waste compactor. The only difference is that we have decided to use the slider mechanism in this instead of using the lever mechanism, but the

mechanical advantage is lost, but it won't matter much since we are only going to compress the dust.



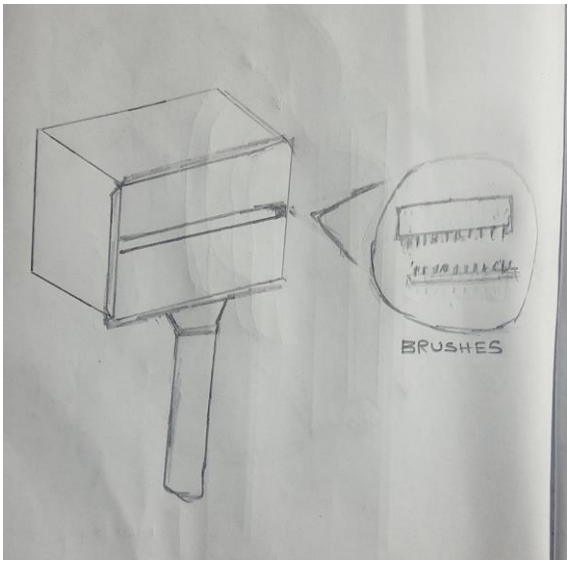
Portable waste compactor design:

1. We designed a bag which can hold a dustbin compactor.
2. Carrying the dustbin with our hand while we are cleaning the fan makes our work complicated so with the help of a bag it makes our work easier. Essentially serves the same purpose as the above two



Fan blade cleaner design:

1. In our vacuum cleaner we customized the cleaning part according to the fan blades.
2. To remove sticky particles like oils and grease we added brushes to our design.



5. CONCEPT EVALUATION

Old fan blade cleaner vs new fan blade cleaner

FEATURES	OLD MODULE	NEW MODULE
Weight	9	8
Number of parts	8	7
Cost	6	9
Clearance	5	9
Suction power	5	9
Volume	**7**	**9**
TOTAL	41	51

SLIDER VS LEVER

FEATURES	LEVER MECHANISM	SLIDER MECHANISM
EFFICIENCY	8	8
MAINTAINANCE	9	6
EASE OF USE	8	6
CAPACITY	7	8
COST	8	5
	41	33

6. APPLICATION OF QFD AND FMEA

QFD

By using QFD to develop a dustbin compactor with vacuum cleaner module for fan cleaning, we can ensure that the resulting product is efficient, user-friendly, durable, and environmentally sustainable, while also being cost-effective and meeting the needs of our target customers

Project title: DUSTBIN COMPACTOR WITH CLEANER
Project leader: MUKUNDHAN
Date: 22-03-2023

Correlation:

+	.	-
Positive	No correlation	Negative

Relationships:

9	3	1
Strong	Moderate	Weak

	Desired direction of improvement (↑,0,↓)									
1: low, 5: high	Functional Requirements (How's) →	Material	Mechanism	Shape	Ecofriendly& safe	capacity		Competitive evaluation (1: low, 5: high)		
Customer importance rating	Customer Requirements - (What's) ↓						Weighted Score	Satisfaction rating	Competitor rating 1	Competitor rating 2
5	cleanliness	1	1		9	3	70	4	3	1
1	attaractive	3	1	9	3	3	19	2	2	3
2	Floor space area		3	9	3	9	48	3	3	3
3	Easy to use	1	9	3		1	42	3	2	2
4	Maintainance	3	9	3	9	3	108	5	3	4
	impotance weighting	23	75	48	90	51				
	relative importance weighting	8.01%	26.13%	16.72%	31.35%	17.77%				
	our value	2	3	3	1	1				
	competitor A	3	2	1	1	2				
	competitor B	2	2	1	1	1	1: very easy, 5: very difficult			
	Target specification values	2	2	3	1	1	1: low, 5: high			

FMEA:

The objective of our FMEA was to identify possible failure modes and avoid those failure modes occurring in the dustbin compactor. It is a modified conventional dustbin by attaching a slider at its side. so that whenever it is about to get filled, a person can slide the slider and with the help of it a metal slab pushes the garbage down making space for more garbage to be filled.

ITEM/ FUNCTON	POTENTIAL FAILURE MODE	POTENTIAL EFFECT OF FAILURE	SEVERITY	POTENTIAL CAUSE OF FAILURE	OCCURENCE	CURRENT DESIGN CONTROL	DETECTION	RPN	PERSON RESPONSIBLE	ACTION TAKEN	SEVERITY	OCCURENCE	DETECTION	REVISED RPN
HANDLE	Breakage of the lever during rotation	Movement of the compactor	7	Unable to withstand the force	4	Using high strength material	8	224	Product Designer	Make the lever and handle single body	4	4	8	128
COMPACTOR	Compactor stuck in between the dustbin	The garbage gets stuck between compactor and bottom	9	Low clearance between the surface of the dustbin body and compactor	6	By leaving a clearance gap	10	540	Design Engineer	Using a gasket around the compactor	5	2	8	80
DUSTBIN BODY	Expansion of the bottom of the body	Burst or damage of the dustbin body	9	Unable to withstand the compression undergone	5	Limiting the compactors compressibility	7	315	Design Engineer	Using material like steel	4	3	7	84
DUSTBIN CAP	Improper closing of the dustbin cap	Lead to bad smell due to improper closing of dustbin cap	5	Misalignment of the cap closing bracket	8	Tight the screw	7	280	Product Engineer	Using closed coil springs at hinge	4	5	7	140

DETAILED DESIGN:

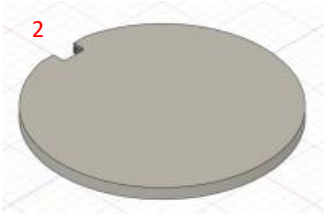
1) WASTE COMPACTOR

A waste compactor is typically designed with many critical components that work together to minimize the volume of waste items. The top cover, which is often composed of a sturdy material such as metal or plastic, is the initial component. The cover has two functions: it acts as a barrier to keep waste confined and as a surface for the user to interact with the compactor. A cylindrical bag within the compactor is designed to collapse when the waste is compacted. The bag is usually constructed of a strong, tear-resistant material, such as plastic or canvas, and is intended to endure the pressure exerted by the compaction process. The bag is linked to the compactor's top cover and may be easily removed and changed when full. The slider is the most crucial component of the compactor since it compacts the waste inside the bag. The slider is a flat panel that may be moved up and down the compactor's length. The bag is empty and ready to receive garbage when the slider is in the "up" position. As waste is introduced to the compactor, the slider moves down, compressing and lowering the volume of the waste. The bag is linked to the compactor's top cover and may be easily removed and changed when full. The slider is the most crucial component of the compactor since it compacts the waste inside the bag. The slider is a flat panel that may be moved up and down the compactor's length. The bag is empty and ready to receive garbage when the slider is in the "up" position. As waste is introduced to the compactor, the slider moves down, compressing and lowering the volume of the waste.

1

4

2



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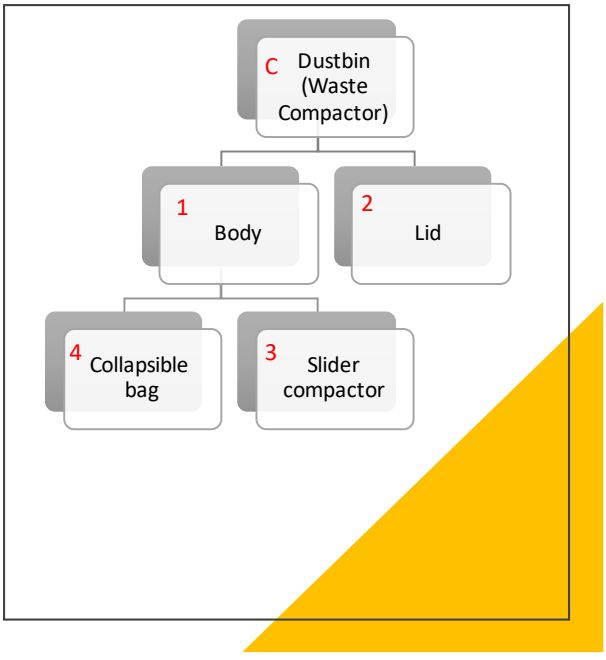
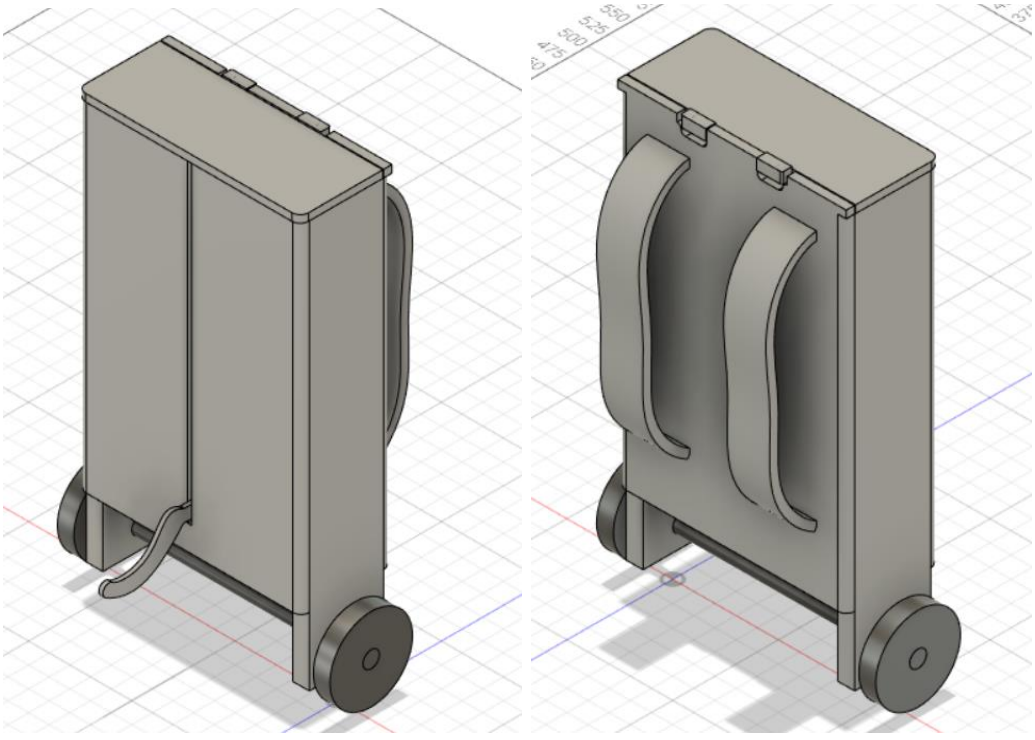
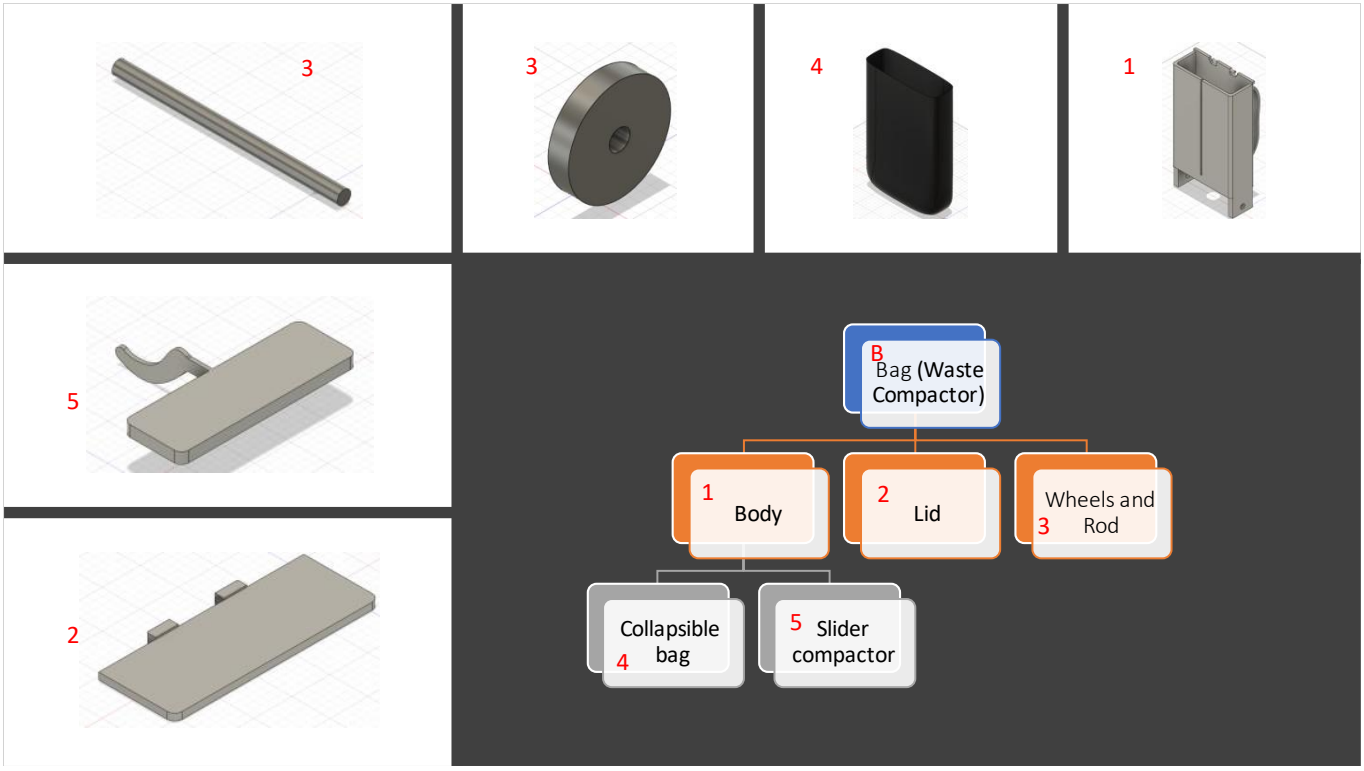

C Dustbin (Waste Compactor)
1 Body
2 Lid
4 Collapsible bag
3 Slider compactor

2) PORTABLE WASTE COMPACTOR

A portable waste compactor is a practical and convenient solution for managing waste materials in various settings. This compact and mobile device is designed to compress and store waste, making it easier to handle and transport. Portable waste compactors are typically compact units that include a collapsible bag or bin for holding waste. The compactor also includes a mechanism for compressing the waste, which reduces its volume and makes it easier to store and transport. Additionally, the device features a handle or strap for portability, allowing it to be easily transported from one location to another. One of the main advantages of portable waste compactors is their mobility and flexibility. Another benefit of portable waste compactors is their ability to compress waste, which not only reduces its volume but also makes it easier to handle and transport. This can result in significant savings in terms of time, labor, and disposal costs. Portable waste compactors are ideal for cleaning small areas or hard-to-reach spaces where waste needs to be managed quickly and efficiently. They can be used in a variety of settings, including offices, hospitals, schools, and construction sites.

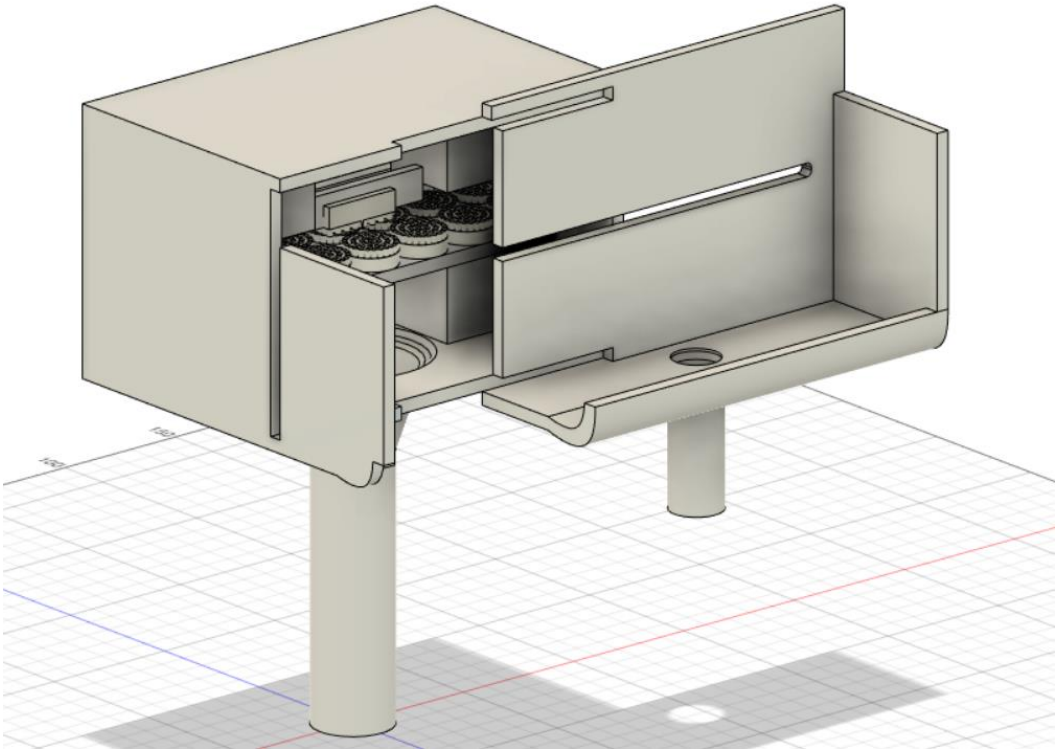


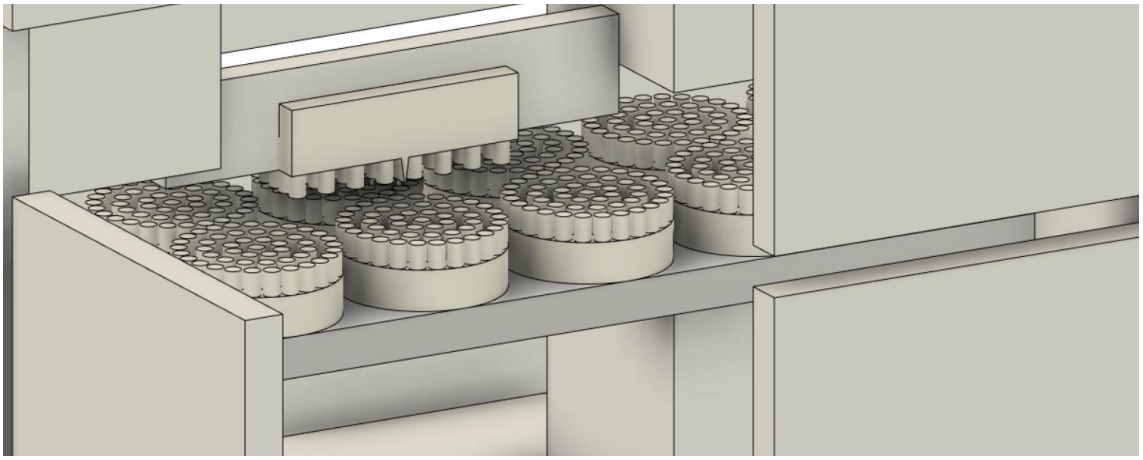


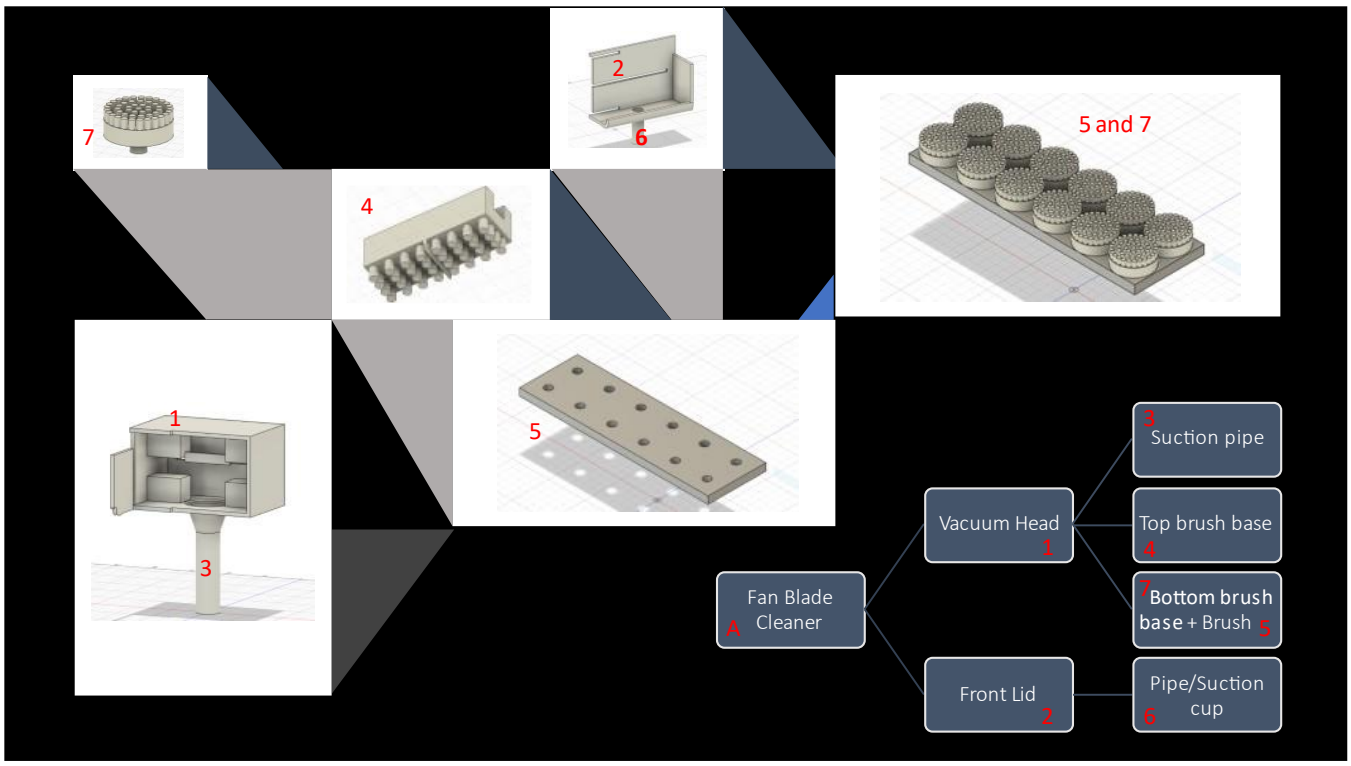
3) FAN BLADE CLEANER MODULE OLD AND NEW

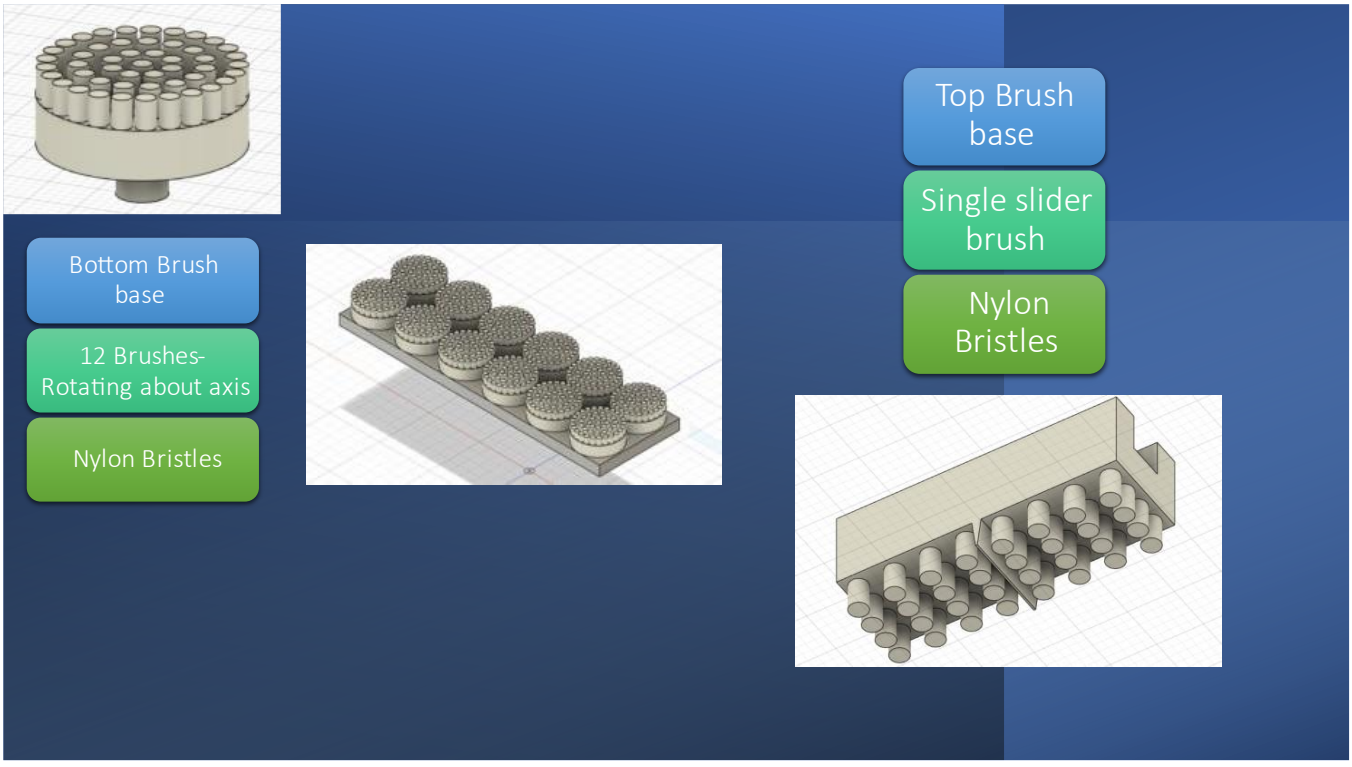
The accumulation of dust on fan blades can lead to decreased efficiency of the fan and decreased air quality in the room. Therefore, the objective is to create a device that can efficiently clean fan blades without causing damage or creating a mess. A review of existing fan blade cleaners and vacuum attachments can provide insights into common features and areas for improvement. Several design ideas were generated, including a cylindrical design with rotating bristles and a vacuum attachment, a flat rectangular design with opposing bristles and a vacuum attachment, a design using compressed air to blow dust off the fan blade and a vacuum attachment, and a design that uses ultrasonic waves to vibrate dust off the fan blade and a vacuum attachment. A possible design for a fan blade cleaner is a cylindrical shape made of durable plastic with a small inlet hole and a larger exit hole for easy insertion and removal of the fan blade. Inside the cylinder are two sets of bristles that move in two directions to clean the fan blade. One set of bristles on the bottom moves in a circular motion, while the other set on the top moves back and forth. The fan blade cleaner is connected to a vacuum cleaner hose via a flexible pipe, which is attached to the exit hole, ensuring that the dust is collected and does not create a mess. The device is easy to disassemble for cleaning and maintenance, and the compact and lightweight design makes it convenient to store and use, making it an excellent addition to any household.

OLD:





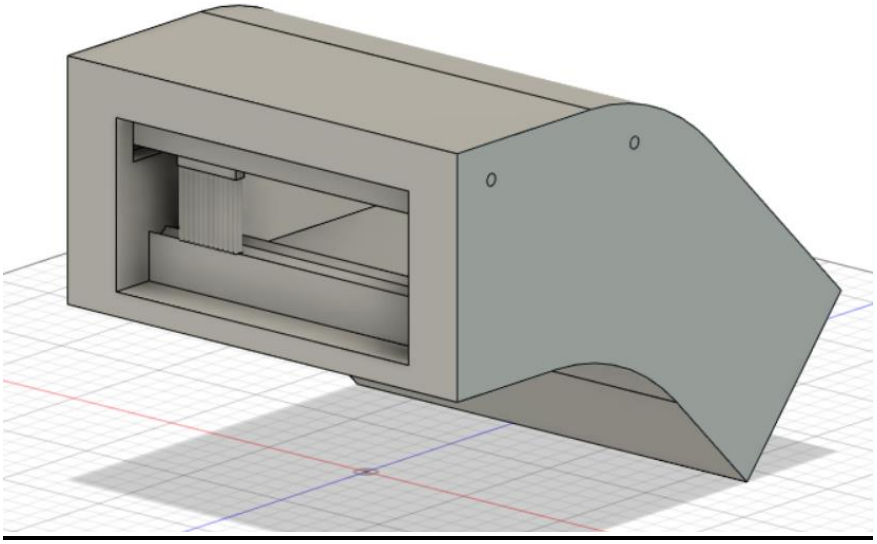

7
2
6
4
5 and 7
1
3
5
Fan Blade Cleaner
A
Vacuum Head
1
Front Lid
2
3
Suction pipe
Top brush base
4
7
Bottom brush base + Brush
5
Pipe/Suction cup
6

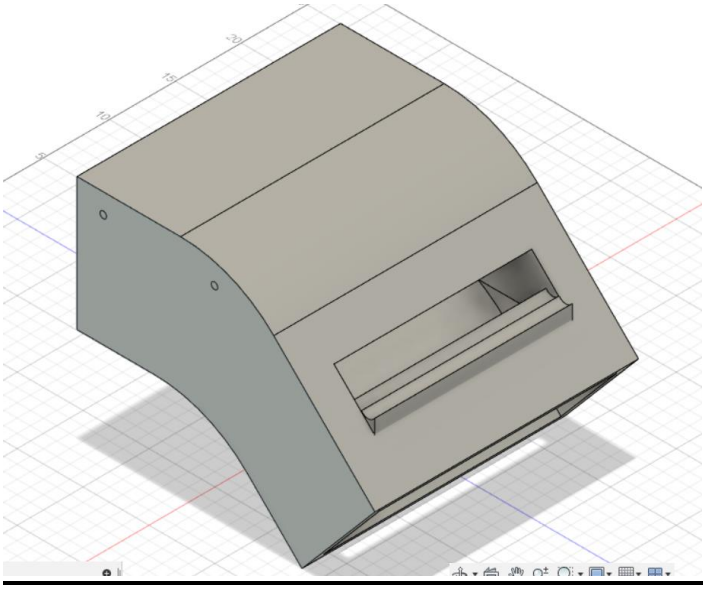

Top Brush base
Single slider brush
Nylon Bristles
Bottom Brush base
12 Brushes- Rotating about axis
Nylon Bristles

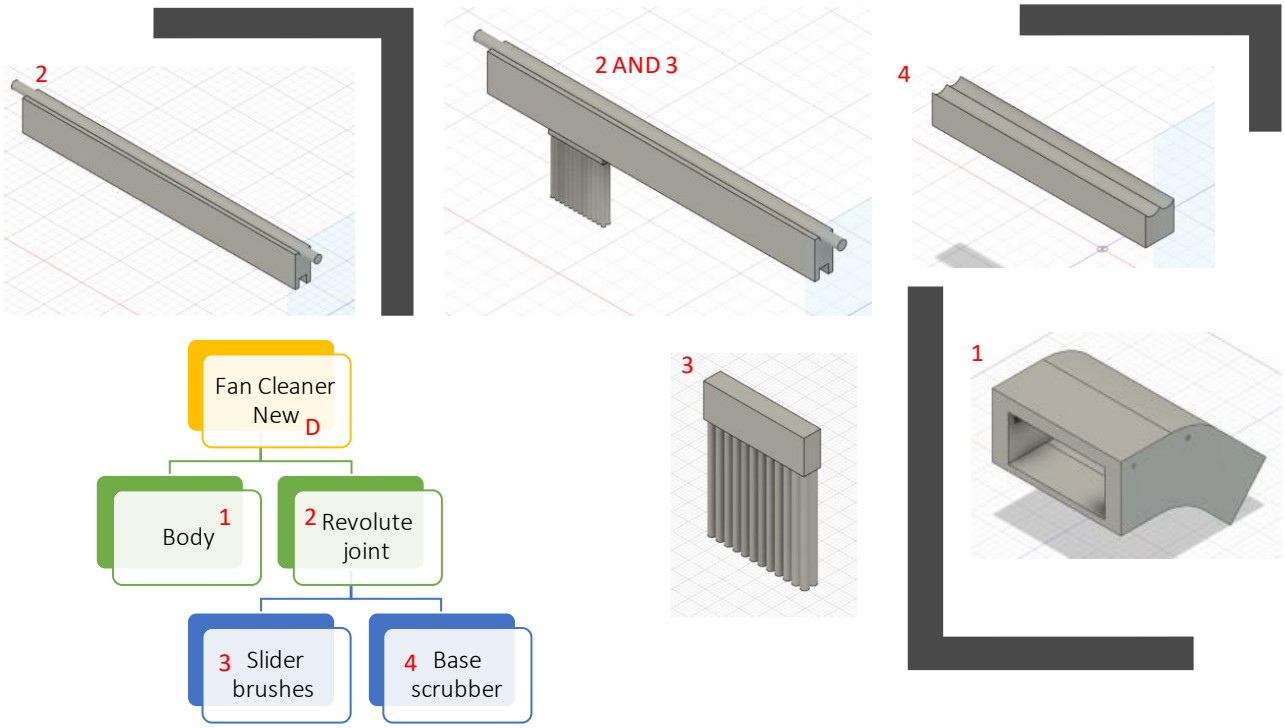
NEW:

IMPROVEMENTS

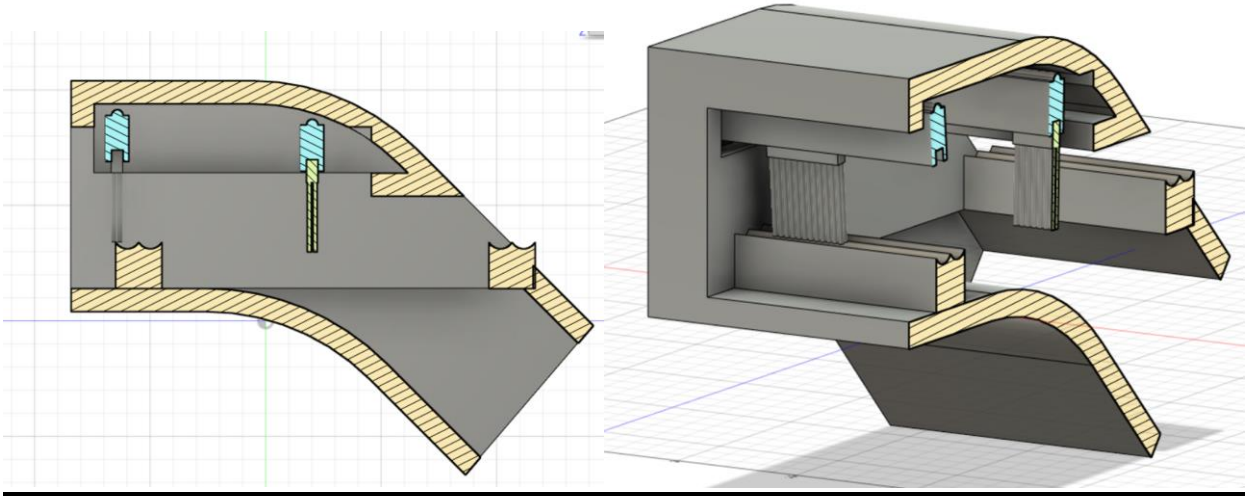
- Clearance because of fan blade airfoil shape incorporated into the design.
- Weight reduction.
- Cost reduction.
- Part consolidation and part reduction.
- More ease of use and easy cleaning.







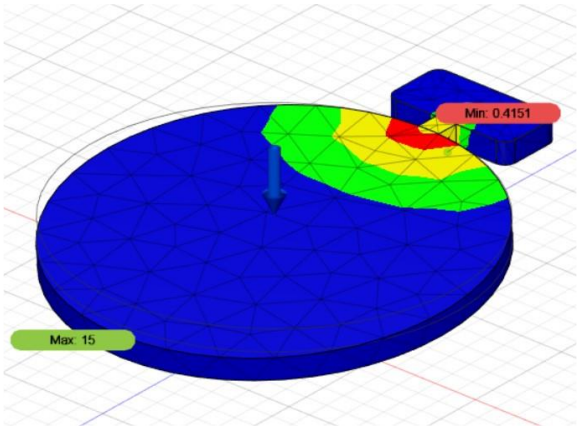
SECTIONAL VIEW OF NEW FAN BLADE CLEANER

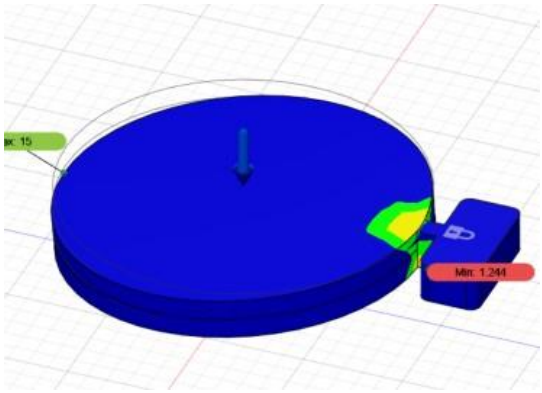


SIMULATIONS

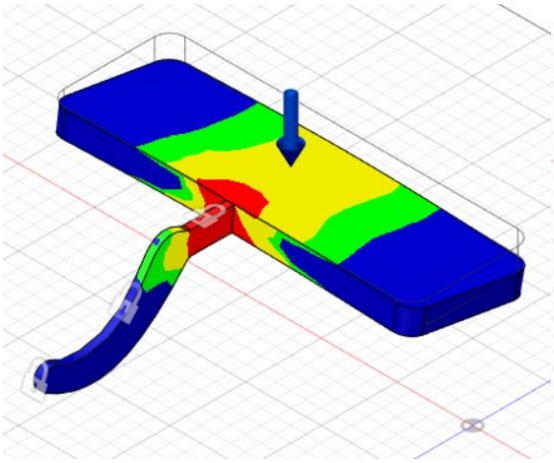
This is done to find the optimal thickness of the slider pad used for compaction of the waste in all the types of waste compactors.

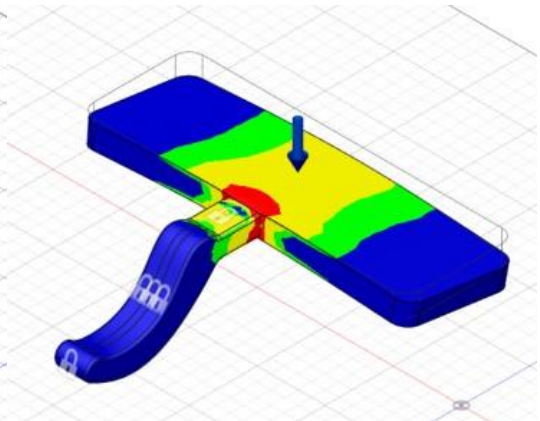
DUSTBIN SLIDER

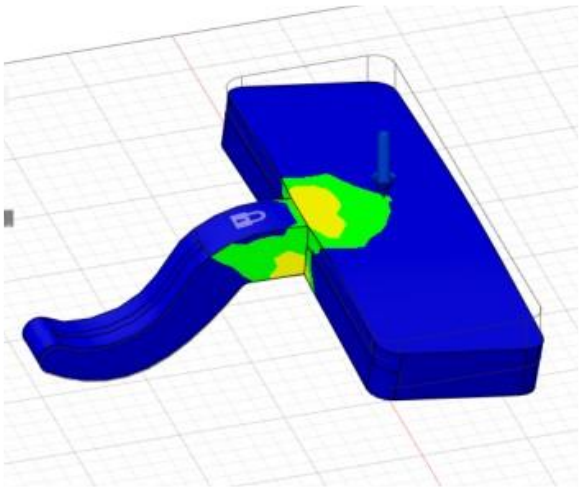


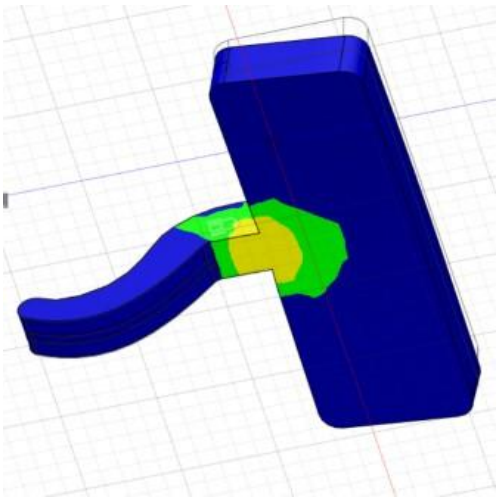


SLIDER IN BAG

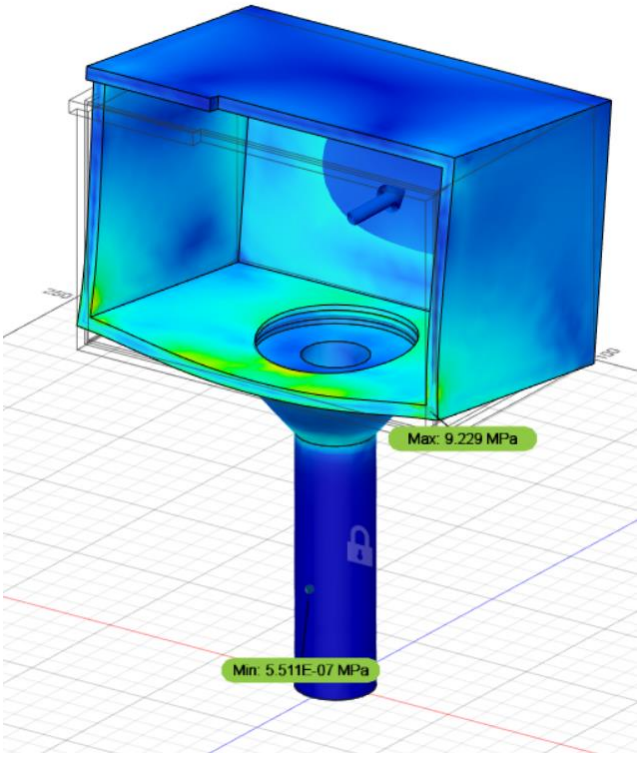






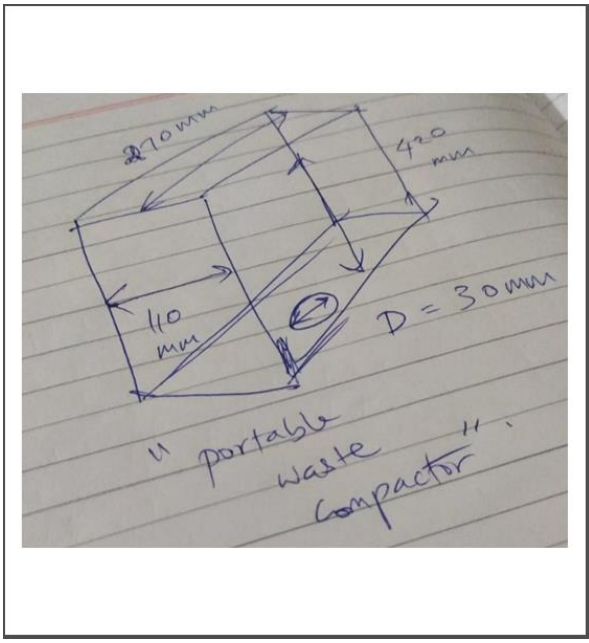


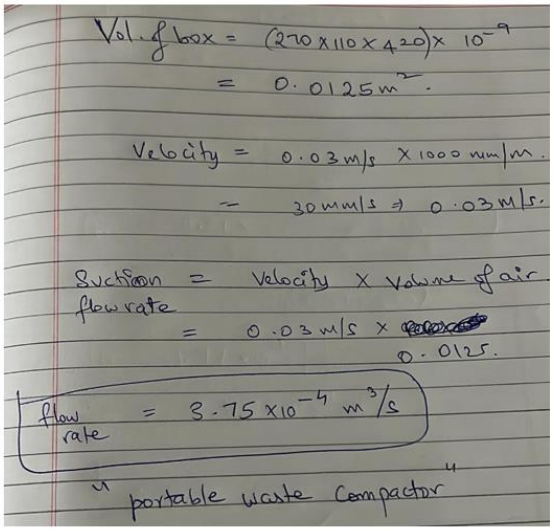
FAN BLADE CLEANER



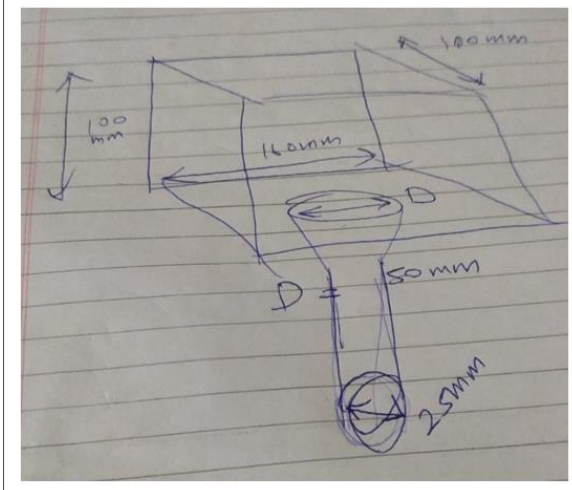
CALCULATIONS INVOLVED IN DESIGN

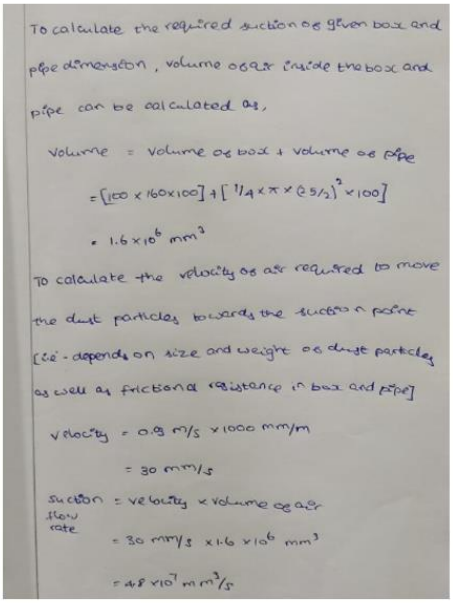
FLOW RATE: (OLD)



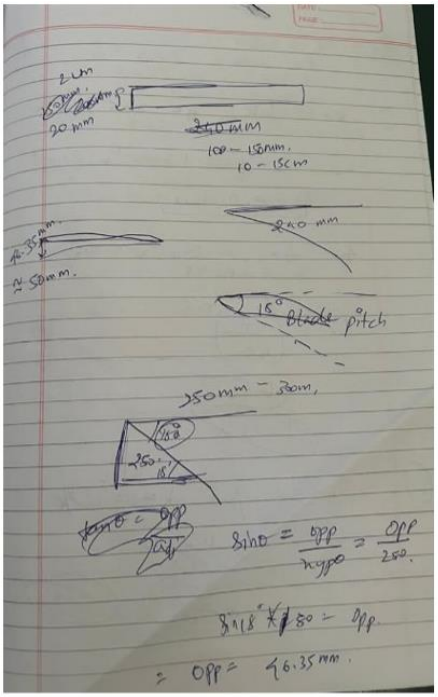


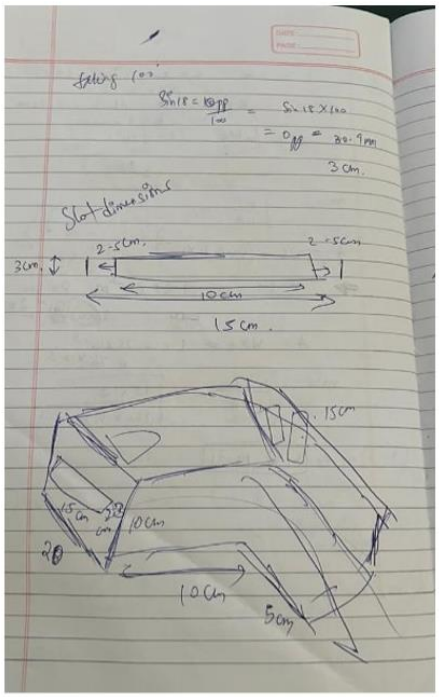
SUCTION FLOW RATE:(OLD)





DESIGN OF NEW FAN BLADE CLEANER BY USING THE INPUT RECEIVED FROM REVIEW 2





To calculate the volume of given box and pipe, suction velocity and suction power for the suction module [both box and pipe] Box i.e 23cm lenght and 10 cm width PIPE i.e 2.5cm dia approximately.

volume of box = lenght x width x height

= 23 x 10 x 10

= 2300 cm³

(or)

= 2.3 Lit [Equivalent]

volume of pipe = π × (diameter/2)² × lenght

= π × (2.5/2)² × 10

= 49.1 cm³

(or)

= 0.0491 Lit

To determine the required suction power,

suction velocity = flow rate / area of pipe

flow rate = 5 m/s × 0.0491 L/s

= 0.2455 L/s

Area of pipe = π (2.5 cm/2)² × 1

= 4.91 cm²

suction velocity = 0.2455 L/s / 4.91 cm²

= 0.05 m/s

suction power = Flow rate × pressure drop

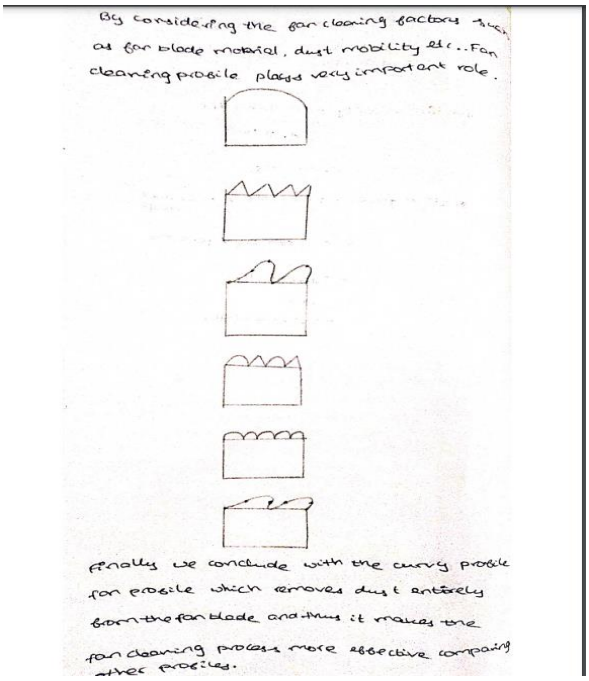
= 0.2455 L/s × 1000 Pa

= 245.5 Pa l/s

(or)

= 0.2455 Watts

SCRUBBER PROFILE SELECTION



DETAILED COST ANALYSIS

DUSTBIN COMPACTOR (OLD)

SNO	Quantity	Part Name	Material	Mass	Cost (INR)
1)	1	Lid	ABS Plastic	328.334 g	130
2)	1	Slider+ compactor	Aluminium	737.799 g	130
3)	1	Body	ABS Plastic	2763.604 g	1120
4)	30	Disposable Bag	Plastic ,opaque black	343.547 g	300
			TOTAL	4173.294 g	1680

DUSTBIN COMPACTOR (NEW)

SNO	Quantity	Part Name	Material	Mass	Cost (INR)
1)	1	Lid	polypropylene	278.464 g	60
2)	1	Slider+ compactor	Polyethylene, low density	244.294g	40
3)	1	Body	polypropylene	2343.849g	430
4)	30	Disposable Bag	Plastic ,opaque black	343.547 g	300
			TOTAL	3210.154g	830

Mass reduced: 963 g

Cost reduced: 850 Rs

FAN CLEANER MODULE(OLD):

SNO	Quantity	Part Name	Material	Mass	Cost(INR)
1)	1	Front-Kid	ABS Plastic	69.738 g	30
2)	1	Brush Base	Aluminium	67.019 g	10
3)	12	Brush	Nylon 6	2.386 g	0.17
4)	1	Vacuum-Head	ABS Plastic	500.537 g	200
5)	1	Slider Brush	Nylon 6	2.508 g	0.01
6)	1	motors	-		5000
7)	1	Dustbin that collects dust	-		1000
8)	1	Filter			1500
9)	1	Hose(connector)	-		800
10)	1	Wand extends	-		700
11)	1	Cord supplies to motor	-		1000
12)	1	Nozzle cleans various surfaces	-		1200
			Total	644 g +2.7kg(Vacuum) =3140 g	11,440

NEW FAN CLEANER MODULE

Quantity	Part name	Material	Mass	Cost
1	Vacuum head	polypropylene	668.662 g	100
2	Slider/turner mechanism	polypropylene	30.26 g	5
2	Brush	Nylon 6,6	4.251 g	2
2	Bottom brush	polypropylene	48.60 g	8
			751.2 g + 2.7 kg(Vacuum) = 3.45 kg	115 Rs + 8350 Rs (Vacuum) 8465 Rs

Mass increased : 300 g
Cost reduced: 2975 Rs

STORAGE BAG (OLD)

SNO	Quantity	Part Name	Material	Mass	Cost(INR)
1)	1	Slider+ compactor	ABS Plastic	317.945 g	80
2)	1	Top Lid	ABS Plastic	263.738 g	75
3)	1	Storage Housing	ABS Plastic	3705.684 g	1520
4)	1	Storage Bag	Plastic, opaque black	10 g	10
5)	1	Brush	Acetal Resin, Black	19.586 g	10
			Total	4305 g	1695

Mass reduced: 1348 g
Cost reduced: 1115 Rs

(NEW)

SNO	Quantity	Part Name	Material	Mass	Cost(INR)
1)	1	Slider+ compactor	Polyethylene, low density	244.294g	40
2)	1	Top Lid	polypropylene	278.464g	60
3)	1	Storage Housing	polypropylene	2405.684 g	460
4)	1	Storage Bag	Plastic, opaque black	10 g	10
5)	1	Brush	Acetal Resin, Black	19.586 g	10
			Total	2957.1g	580

(OLD)

Total cost : 14,815
Mass : 11.8 kg

(NEW)

TOTAL COST: 9,875 Rs
TOTAL MASS: 9.8 kg

8. CONCLUSION

In conclusion, our project aimed to develop a dustbin compactor with a slider mechanism to compress the dust that is collected from a fan blade cleaner module attached to a vacuum. The objective was to make the disposal of dust and debris more efficient and convenient for the user.

Through extensive research and development, we successfully designed and implemented a slider mechanism that effectively compresses the dust, allowing for more space within the dustbin. Furthermore, the addition of a fan blade cleaner module with a vacuum was an innovative solution to efficiently clean and collect debris from hard-to-reach areas.

Overall, our dustbin compactor with slider mechanism and fan blade cleaner module is a practical solution for both residential and commercial settings. It not only simplifies the process of dust disposal but also improves the effectiveness of cleaning, ultimately saving time and effort for the user. With further improvements and potential commercialization, this project has the potential to make a significant impact on the cleaning industry.

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