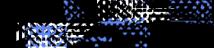
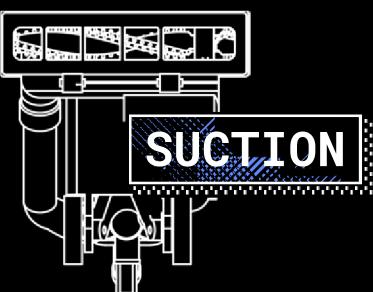


COMPONENT ROLE & FUNCTION

ME30356 Reverse Engineering
Callum Morrison
VAX UCPESHV1



MAIN PRODUCT FUNCTIONS



SUCTION

AIR PATH

- Route from entering to exiting the vacuum
- Longer path may **reduce suction**, or increase change of blockages



FILTERS



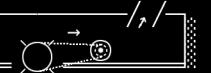
- Filters are a significant source of suction loss
- Blocked filters **reduce airflow**
- In cyclone design, filters are a last resort for catching dirt; they stay clean and block little

BRAH BAR & TURBO TOOL

- Increases efficiency of available suction by **brushing dirt into path of airflow**, making it easier to pick up



BOTTOM OF BRUSH BAR
SWEEPS ALONG FLOOR
PICKING UP DIRT



BOTTOM BRUSH BAR POWERED BY 150W
MOTOR. TURBO TOOL POWERED BY
TURBINE IN AIRFLOW PATH

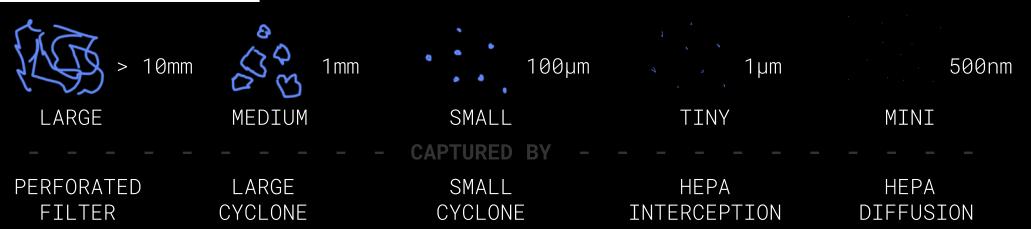
CYCLONIC SEPARATION

- The method in which captured dust or dirt is **separated from the airflow** is through a method called **cyclonic separation**
- Most new vacuum cleaners use this method DYSON | VAX | HOOVER | SAMSUNG | VONHAUS
- Further analysis performed in Deep Dive

FILTERS

- Final barrier against tiny dirt particles
- HEPA filter removes > 0.3µm particles
- Large filter for fluff / hair

PARTICLE SIZE

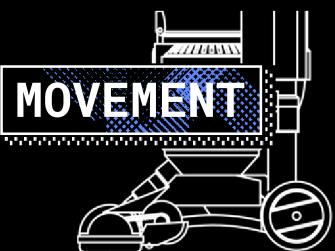


EMPTYING

- Paths from perforated filter and cyclones lead to bottom of dirt container
- HEPA filter must be cleaned manually, otherwise dirt will build up over time

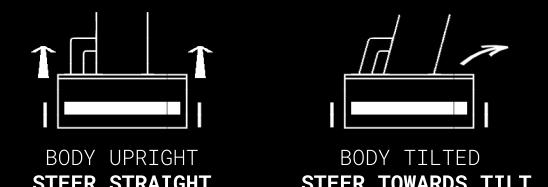


MOVEMENT



WHEELS & STEERING

- Steering controlled by tilt mechanism



- Main wheels on rear of base, **independent** to allow for turning
- Not powered, broke, or otherwise actuated, as this is not required here
- **Small rollers act as wheels** at the front to prevent scratches, can slide

SLIDING

- Attaching hard floor adaptor changes movement function through small rollers to **sliding on hard plastic / felt pads**. Only effective on hard floors.

HANDLES

- Control of the vacuum is primarily done through the main handle
- **Push, pull, and tilt** required

TWO GRIP LOCATIONS

ALLOWS REPOSITIONING
WHEN PUSHING / PULLING
OR TILTING

CABLE HOOK

ALLOWS ATTACHMENT
OF CABLE OUT OF WAY

USE OF COLOUR

TO INDICATE WHERE HANDLE
SHOULD BE GRIPPED

HOSE & ACCESSORIES

- Use of any accessories (Turbo Tool, 3in1, extendible arm) **requires movement** through different means
- Each accessory interfaces differently with the user; allowing for **different types of movement**

SINGLE HAND GRIP
ALLOWS FOR EASY
MOVEMENT WITH
EITHER HAND

EXTENDED HANDLE
ALLOWS REACH TO
HARD TO GET TO
AREAS

SIMILAR FUNCTION AND MECHANISM TO MAIN
POWERED BRUSHBAR, HOWEVER IS PASSIVE

THE PRODUCT CAN BE SPLIT INTO SIX MAIN FUNCTIONS
EACH OF THESE SPLIT INTO MULTIPLE SUBFUNCTIONS



INTERFACE



BUTTONS

- Main method of control over the vacuum cleaner
- **Three primary functions**
- Generic, recognisable icons to help new users
- **Some icons new** (brush bar) and may not convey function
- **Tangible** push toggle; button retracts when active to convey function
- **Spring action** through button or dedicated spring



POWER



EJECT
DUST
CHAMBER



ENABLE
BRUSH
BAR

WRITING HINTS

- Multiple functions outlined in **English** on product itself
- Conveys information without use of manual or potentially **confusing symbols**

Clip hose here

CLEAR
INFORMATIVE

Wand release

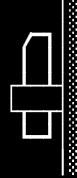
INDICATOR LIGHTS

- Simple indication of brush bar
- Extra functionality could be added through extra lighting



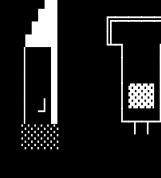
TOOL CLIP

- Used by the user to **join 3in1 tool** and the **main body**
- Pull off to release
- Push on to attach
- **Minimal complexity** to achieve function



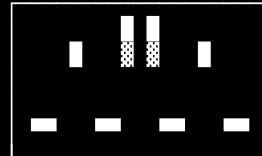
ACCESSORIES

- Upholstery brush
- Turbo tool
- 3in1 tool
- Used to affect vacuum / surface interference
- **Modular**



PLUG & CABLE

- Interface between product and **existing home utilities** / main power supply
- Cable provides link between fixed plug socket and movable vacuum cleaner
- Must allow flexibility and compatibility



DUST STORAGE



BRUSH BAR DISASSEMBLY

- Manual outlines removal of brushbar assembly
- Brushbar side covers to **prevent dirt escaping**
- Belt is replaceable upon wear or damage
- **Brushbar may tangle** with hair impeding its functional requirement to spin; manual states to remove any before re-installation



DUST CONTAINER DISASSEMBLY

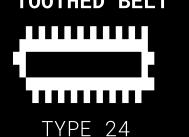


- Over time **dust will build** up on inside of dust container, this will block airflow holes and reduce suction power; reducing functionality
- **Cleaning to remove blockages** will improve airflow and restore suction

REPLACEABLE PARTS

- Many parts are consumables, and many more are available from vax.co.uk for **replacement after wear or damage to originals**
- To simplify replacement process, consumables are labelled with a Vax 'Type'

TOOTHED BELT



TYPE 24

FILTER KIT



TYPE 90

VACUUM HEADS

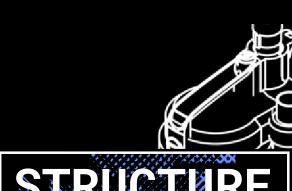


TYPE 2

TURBO TOOL



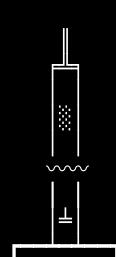
TYPE 6



STRUCTURE

SPINE & HANDLE

- Unlike other styles of vacuum such as handheld or canister, upright vacuums require an **upright structure** to hold all required components
- This product requires **two main structural components**, due to the lift out mechanism, the 'spine' and 'backbone'

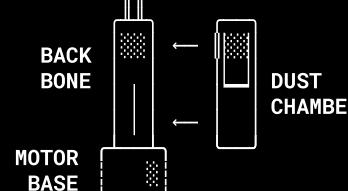


MOTOR BASE & BACKBONE

- Not only must design provide **structural rigidity** to the design in lift - out mode, but also all **electronics** to allow the vacuum to function must be contained within
- Motor base has cable connection, and backbone contains channels to **allow air flow**
- Dust chamber unites with base and backbone to form **lift out** design

DIRT CONTAINER

- The dirt container is not only a housing for all dirt and debris to be captured by the vacuum, but it contains all of the components required for **cyclonic separation**; required for the vacuum to function

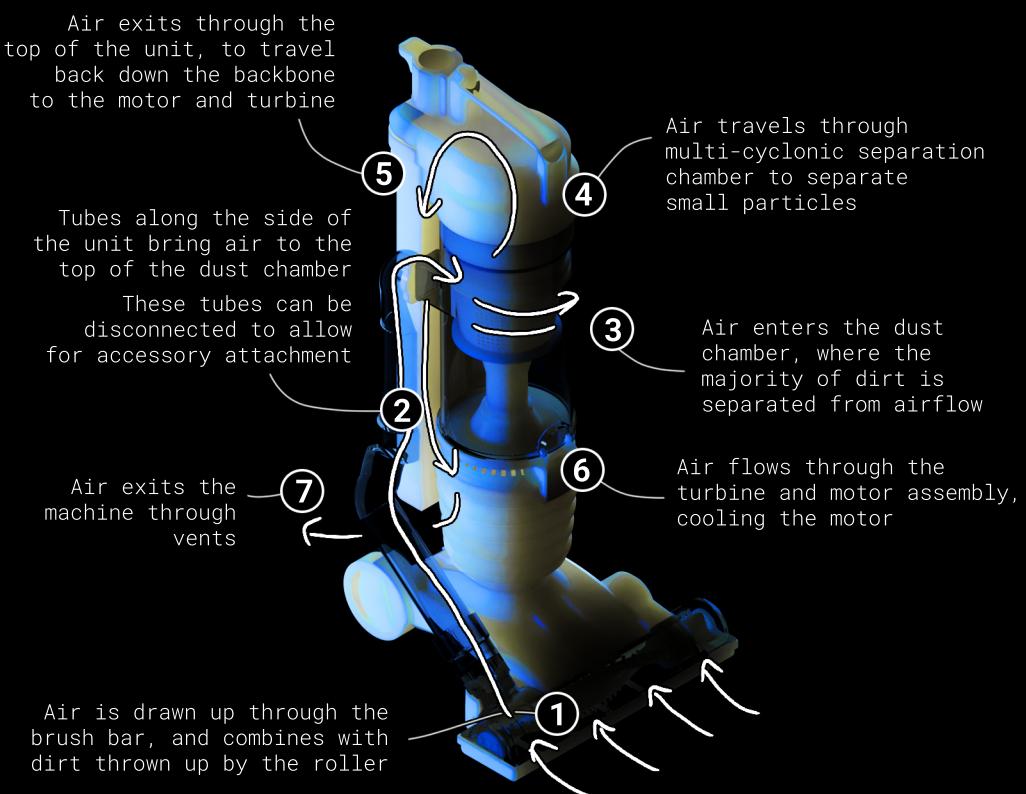


COMPONENT ROLE & FUNCTION

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DEEP DIVE

AIR PATH through the product will largely determine the path that dirt or debris collected by the vacuum will follow. Separation of air and dirt is vital, to prevent dust being blown back into the room.



CYCLONIC SEPARATION is used as the primary method of separating intake air and captured dirt (as opposed to filters or bags). It requires helical cyclones or vortexes of air travelling down the outside of a cone. Heavy particles (dirt) have higher inertia than the air, and therefore fly to the outer wall of the cyclone, where they fall down out of the airflow.

DIRT CONTAINER

1. Air flows into the dirt chamber at one edge. It begins to follow a **helical path** around the perimeter of the outer wall.

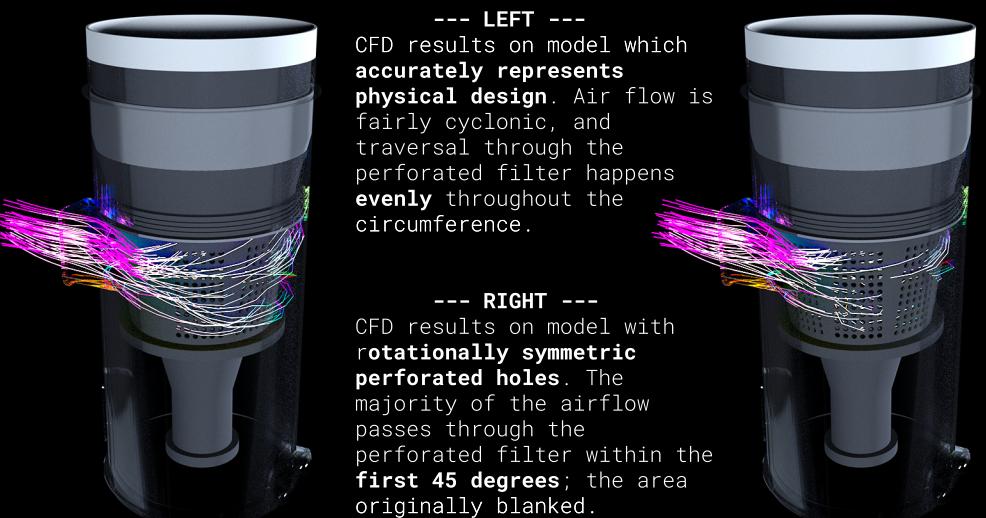
2. Through cyclonic separation, some **dirt falls down**, collecting at the base of the chamber. Primarily large (~1mm), heavy particles will be separated here.

3. A **perforated filter** is used to block large, but low density particles such as pet hair.
4. Air flows up the chamber into the **second cyclonic separator**, which consists of seven smaller cyclones. Due to the smaller radii, air will change velocity at a greater rate, and so smaller particles (~100µm) are now thrown to the edge, and fall down to the bottom of the dust chamber.

5. As a final precaution, a **HEPA filter** will separate the smallest particles (~500nm) from the airflow.



COMPUTATIONAL FLUID DYNAMICS was used to determine the effect of the perforated filter, on the first cyclone. At the location that air enters the dust chamber, the perforations are blanked out for 45 degrees. Two different CAD models were analysed, one true to the physical design, the other with the perforations added back for this section. It was found that blanking the holes at the entrance had a significant effect on cyclone formation.



Without the perforation blanking, **one segment** of the perforated filter would be responsible for much more separation than any other; meaning buildup of dirt, hair etc. would occur **much faster**, creating blockages and **reducing suction**.

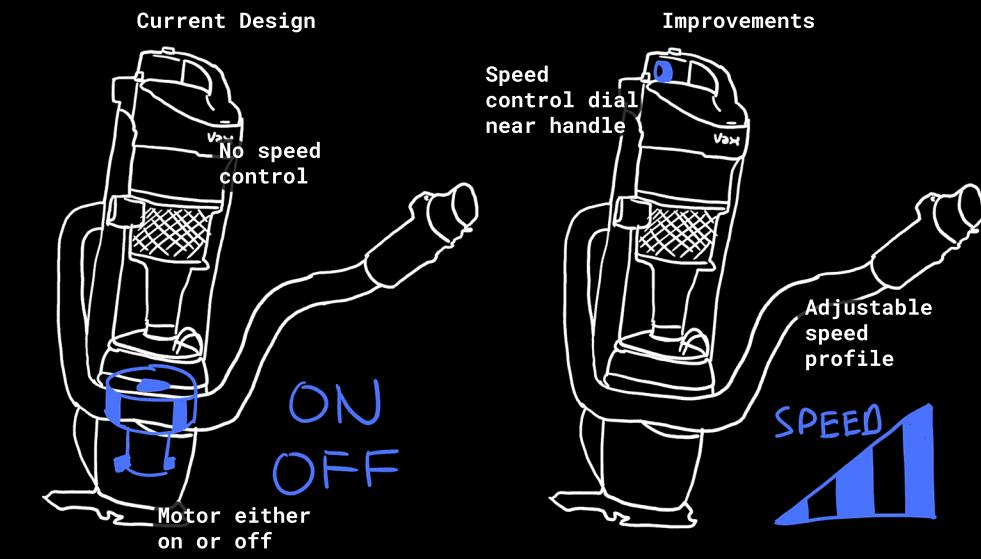
ILLUSTRATION OF PARTICLES CAPTURED BY CYCLONE

IMPROVEMENTS

ADJUSTABLE SUCTION POWER. In product testing, it was found that on some low quality carpets, the product was powerful enough to cause damage and excessive wear. While testing a competitor product, it was observed that a rotary dial could vary the motor power, and therefore the suction performance. Implementing this function would help minimise risk of damage to some surfaces.

Highlighted issues:

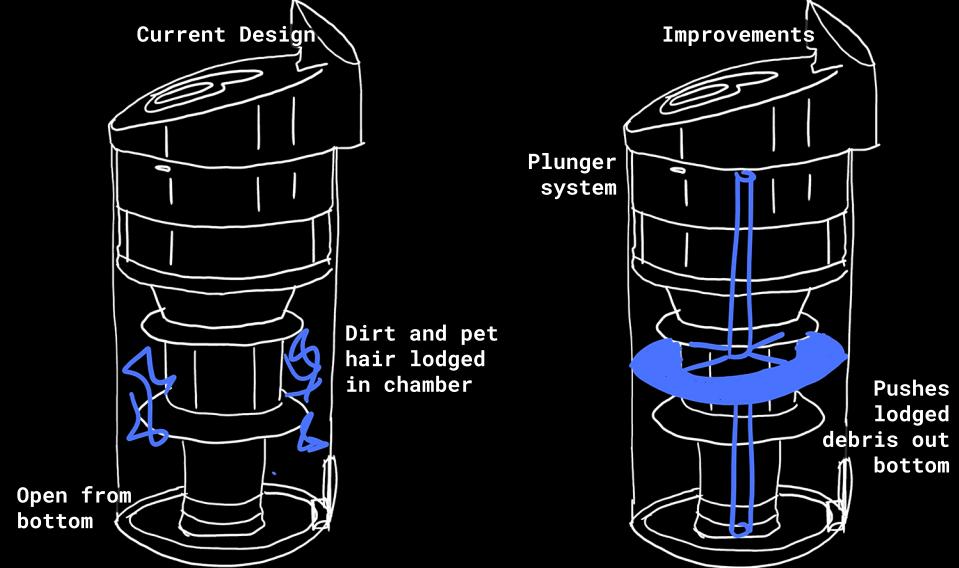
1. No control over suction power
2. Suction can be too strong for some carpets



DIRT CHAMBER PUSH OUT. It was found in testing that large clumps of dirt or pet hair would sometimes become lodged within the dirt chamber. Some competitor products use an ejector plunger to force empty the dirt chamber.

Highlighted issues:

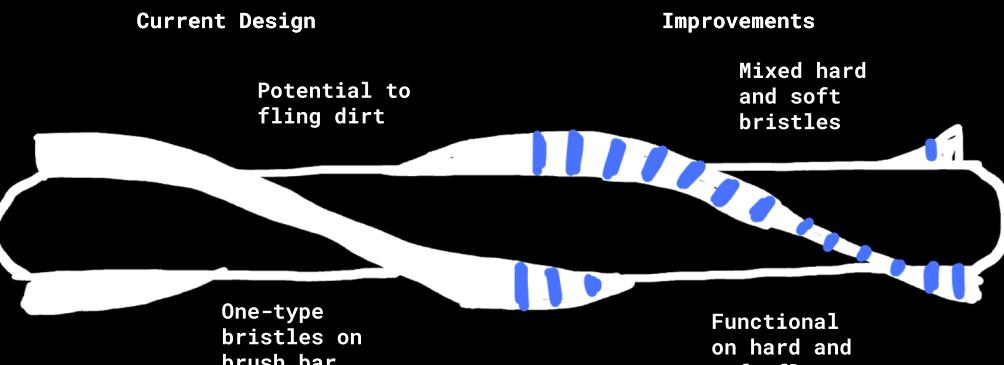
1. Dirt and large fibres will become lodged in dirt chamber, and require reaching inside to remove



BRUSH BAR TUFT MATERIALS. During a talk from a Dyson employee, it was mentioned that their products use two different materials for their brush bar tufting, one soft and one stiff. They discovered that stiffer fibres work well on carpets, and soft fibres prevent flinging of dirt across hard floors.

Highlighted issues:

1. Brush bar contains only stiff tufting fibres
2. Softer tufting fibres would help minimise 'dirt fling' on hard floors



STEERING WHEELS. One of the main areas of issue found while user testing the product was the steering mechanism. Although sometimes it worked without issue, at other times it was hard to steer, especially in tight spaces.

Highlighted issues:

1. Product sometimes difficult to steer
2. Steering can be unpredictable

