Issue 2, Volume 1, No. 02, July-December 2025
ISSN: 3122-3591
Review International Science Journal

Design and Validation of the Vortrix Industrial Blower for Dual Function Cleaning Applications

***TSU. Jesus Jahir Estrada Ledesma**
UTNG
jesusestradaledesma @gmail.com
https://orcid.org/0009-0001-7446-5797

TSU. Juan Manuel Baliño Pérez
UTNG
balinoperezjuanmanuel@gmail.com
https://orcid.org/0009-0004-9219-9236

TSU. Fabricio Barbosa Varela
UTNG
fabribarbosavrl1015@gmail.com
https://orcid.org/0009-0001-7125-7060

PhD. Alfredo Gutiérrez García
IECCMEXiCO
alfredo.gutierrez@utng.edu.mx
https://orcid.org/0000-0002-8197-8144

Received: 10-07-2025 | **Accepted:** 10-13-2025 | **Published:** 10-14-2025

*** Corresponding Author:** *jesusestradaledesma @gmail.com*

How to cite this article: Estrada Ledesma, J. J., Baliño Pérez, J. M., Barbosa Varela, F., & Gutiérrez García, A. (2025). Design and Validation of the Vortrix Industrial Blower for Dual Function Cleaning Applications. México. TheSci Review, 1 (1) 84-106. Quality Consulting Instituto de Educación Capacitación y Certificación de México. https://ieccmexico.com/thesci

ABSTRACT

The Vortrix industrial blower represents an innovation in industrial cleaning equipment by integrating two essential functions—high-power blowing and robust vacuuming—into a single ergonomic device. This article's main objective is to document the design, development, and validation process of this dual-function product, which was conceived to optimize maintenance tasks in industrial environments and workshops by eliminating the need for multiple tools and reducing operator physical effort. The methodology used in the product's development combined a user-based approach, structured in sequential phases including conceptualization, supply chain planning, prototyping, field testing, mass production, and rigorous quality control, to ensure the design addressed real needs identified through market research. The results obtained demonstrate the technical and functional viability of the concept, as the prototypes validated the efficiency of the dual system, showing a significant reduction in task execution time and high user acceptance due to its ergonomics and ease of use. Ultimately, the Vortrix project not only delivers a practical and efficient solution to the market but also validates a user-centered and process-driven development model, laying the groundwork for future innovations in multifunctional industrial equipment.

KEYWORDS

Mechanical factors; Mechanical engineering; Flow graphs; simulation; Computer simulation; CADCAM.

INTRODUCTION

Issue 2, Volume 1, No. 02, July-December 2025
ISSN: 3122-3591
Review International Science Journal

In today's market, there is a growing, daily demand for versatile, efficient, and user-experience-centered industrial equipment, which has driven the need for innovative solutions to optimize maintenance and cleaning processes. It is in this context that the Vortrix industrial blower emerges as a high-impact technological proposal, integrating two critical functions—high-power blowing and robust vacuuming—into a single ergonomic device. Its technological relevance lies in the engineering applied to combine mechanical and pneumatic systems in a compact unit without compromising performance, while its social relevance is based on reducing the operator's physical effort and improving productivity in work environments such as mechanical workshops, factories, warehouses, and even large-scale domestic spaces.

Along these lines, the central problem this article addresses is the operational inefficiency derived from using separate tools for blowing and vacuuming debris. This fragmentation not only increases operational and logistical costs but also prolongs task execution times and generates unnecessary user fatigue. Under this premise, Vortrix seeks to solve this problem through a dual-functional design that eliminates the need to switch tools, allowing a seamless transition between modes and optimizing the workflow. For this reason, this approach represents not only a functional improvement but also an advance in user-centered design within the industrial equipment sector.

DEVELOPMENT

The problem addressed by the project focuses on demanding operating environments where technical cleaning and the removal of solid and fine waste must be performed frequently, under short time windows, and with minimal equipment downtime. In these heavy-duty situations, using separate devices for blowing and vacuuming increases downtime, travel, and handling costs, in addition to increasing operator fatigue and the risk of recurrent dirt due to particle recirculation. The proposal integrates blowing and vacuuming into a single unit capable of alternating functions instantly, with structural strength and pneumatic performance sized for long cycles, large surfaces, construction debris, shavings, and fine dust, while maintaining ergonomics and safety for full shifts.

The design is structured as a compact and robust rolling system that combines a highly rigid chassis, large-diameter wheels for stable handling on even surfaces, protective housings, and a central pneumatic assembly with a high-speed turbine. Switching between blowing and suction is achieved through a sealed flow diversion integrated into the main duct and an interchangeable nozzle, controlled from a manual panel accessible on the handlebar. The air intake system is complemented by a pre-filter and high-efficiency cartridge to retain fine material, integrated into a removable collection tank that facilitates emptying and cleaning without tools. The mechanical architecture is based on an upper, lower, and central cover that encapsulates the engine, ducts, and wiring, while the support shaft ensures wheel alignment and stability during travel and maneuvers. The user interface incorporates an informative display for operating status and service alerts, with start-up and adjustment controls located within easy line of sight and reach. The selection of materials favors lightweight alloys and technical polymers to balance mass, durability, and cost: aluminum for the chassis and critical tubular elements; ABS, polycarbonate, or polypropylene for housings and covers for their impact resistance and ease of molding; high-density polyethylene for tanks; Elastomers in wheels and grips for cushioning and traction. The modularity of the assembly (chassis, pneumatic module, filters, tank, hoses/nozzles, and electronics) simplifies assembly, preventive maintenance, and the replacement of high-turnover parts. It also allows for scaling to higher-capacity variants without redesigning the base platform. The dimensional and tolerance integration in ducts, nozzles, and fittings aligns with the required flow performance and the geometric fit of the housing, maintaining manufacturability and repeatability.

Market viability is based on three factors. First, the direct economic value to the customer through functional consolidation: a single asset replaces two, reduces inventory and separate spare parts, shortens tool changeover times, and reduces transportation, which measurably impacts productivity per shift and the total cost of ownership. Second, in technical suitability for rugged use: the combination of a rigid structure, stable rolling, high-efficiency filtration, and an easily detachable tank enables continuous operations in large spaces with diverse soiling, increasing effective availability without increasing operational complexity. Third, in capacity-demand and unit profitability: with assembly times of approximately twelve hours per unit in a three-operator cell with an eight-hour workday and eleven productive months with clear scalability, annual capacities of approximately one hundred and sixty units are achieved, sufficient to meet base demand scenarios of one hundred units with room for variations.

GENERAL OBJECTIVE AND SPECIFIC OBJECTIVES

GENERAL

Issue 2, Volume 1, No. 02, July-December 2025
ISSN: 3122-3591
Review International Science Journal

The purpose of this study is to design, develop, and validate the Vortrix industrial blower, an ergonomic device with dual blowing and extraction functions, aimed at optimizing cleaning and maintenance processes in industrial environments and workshops. This ensures greater operational efficiency, reduces user physical effort, and consolidates a user-centered, process-based development model.

SPECIFIC

1. Apply mechanical and pneumatic design principles to integrate the blowing and extraction functions into a single compact prototype, maintaining high performance standards.
2. Develop a functional prototype of the Vortrix blower, considering the conceptualization, supply chain planning, assembly, and field testing phases.
3. Evaluate the technical and functional feasibility of the prototype through FEA and CDF simulations that simulate real-life industrial scenarios, measuring execution times and user acceptance.

OBJECT OF STUDY

The object of this research is the design, development, and validation of the Vortrix industrial blower, a multifunctional device that integrates high-power blowing and robust suction functions into a single ergonomic device to optimize cleaning and maintenance tasks in demanding industrial environments.

The objective is to evaluate its technical, functional, and ergonomic performance, as well as its feasibility for implementation in maintenance and cleaning processes where separate equipment is currently used. This will help to streamline operator time and physical effort, increasing shift productivity and effective equipment availability.

The study population consists of mechanical workshops, factories, warehouses, and industrial or semi-industrial spaces that frequently require the removal of solid and fine waste under short timeframes and are seeking to replace multiple devices with a single, compact, reliable, and ergonomic device.

METHODOLOGY

User-Centered Design is defined as an iterative and empirical process that converts real operator needs into measurable specifications that guide engineering, testing, and business decisions. At Vortrix, it will be applied to validate that the integration of blowing and vacuuming in a single device eliminates tool changes, reduces physical effort, and shortens cleaning times in workshops, factories, and warehouses. The methodology begins with the collection of customer feedback in a real-life context and translates it into critical quality, performance, safety, and maintainability requirements. It advances with the synthesis of requirements and product architecture to resolve technical compromises such as power, weight, and center of gravity distribution. It continues with ideation and co-design. It is supported by traceable indicators from the customer's feedback to test results such as perceived acceptance, workload, posture, and cleaning cycle. It is complemented by quality and reliability dashboards in pilot and post-launch releases to close gaps. Adoption is strengthened with operational training and user and maintenance manuals aligned with identified risks. Success will be measured by an objective reduction in cycle time compared to practice. current, reduction of operator fatigue through optimized ergonomics, minimization of mode errors through an intuitive interface, and stability of performance in production with high first-pass yields and low failure events, with this methodology the final design not only meets the technical and operational requirements but also demonstrates, with field evidence and full traceability, that the solution is desirable for the user and viable for the business.

The methodology that will be used in the present study is the user-based methodology, which according to [3] mentions that it is acquired when a person interacts with the specific design, this is substantially important, when it comes to computational validation through CFD and FEA of the elements that make up VORTEX. Thus, the methodology consists of the following stages:

1. **Understanding the user context:** In this first stage, a thorough analysis is made of who the user is, what their characteristics are, and under what conditions they will use the solution. To do this, I use techniques such as interviews, direct observation, surveys, and task analysis, which allow me to build a detailed and realistic profile [1]. This allows me to identify limitations, capabilities, cultural and technical factors that influence the experience [2]. This approach is in line with what is stated in the literature, which emphasizes that knowing the context is essential to achieve a user-centered design, since it ensures that the solution responds to authentic needs and not to assumptions [3].
2. **Specify your requirements:** After understanding the context, move on to organizing the collected information into a set of clear, verifiable, and prioritized requirements. Here you define both the requirements functional (actions that the system must execute) and non-functional (ease of use,

Issue 2, Volume 1, No. 02, July-December 2025
Issue 2, Volume 1, No. 02, July-December 2025

accessibility, performance, reliability) [1]. Likewise, consider the technical, regulatory and environmental limitations that could condition the solution [2]. Support from international standards such as ISO 9241-210 and practical user-centered design guides ensures that these requirements are objective and measurable, which facilitates their subsequent validation [3]. In addition, establish priorities to focus resources on what has the greatest impact on the user experience [1][2].

3. **Design the solutions:** With the requirements defined, the creative and iterative stage of the design begins. Multiple alternatives are generated using tools that can help shape the ideas [2]. The objective is to quickly evaluate and refine the ideas before committing resources to a final version [3]. According to the literature, this process should be iterative and participatory, involving the user from the initial stages to validate that the proposal meets their expectations [1]. In addition, apply usability design principles and criteria that facilitate the understanding, consistency and efficiency of the system [5]. Constant iteration ensures that the solution not only meets technical requirements, but also fits in a practical and contextual way to the real needs [2][3].

4. **Evaluate the results:** The final stage consists of verifying that the solution meets the defined requirements and fully meets the user's expectations. Various complementary techniques are used to achieve this:

   i. Testing with real users, in which we observe how they interact with the system in representative tasks and collect quantitative data (execution time, success percentage) and qualitative data (comments, difficulties) [4].
   ii. Usability criteria evaluation, in which experts review the solution applying usability principles to detect design problems that users do not always identify [5].
   iii. Improvement iterations, where findings are fed back into the design to adjust technical and usability aspects until optimal levels of effectiveness, efficiency and satisfaction are achieved [1][4].

This validation process ensures that the final product not only meets the specifications, but is also intuitive, useful and accepted by users [2][5].

PHASES OF DEVELOPMENT

1. Understanding the user context:

a. Survey format to identify potential customers (a structured survey was designed and administered to companies selling cleaning equipment in the state of Guanajuato)

The instrument was based on Malhotra's (2019) [6] guidelines for preparing questionnaires in market studies, ensuring validity and reliability in data collection.

SURVEY

SECTION 1: GENERAL DATA OF THE SURVEYED COMPANY

1. Company name: ____
2. Main business:
   ☐ Sale of professional cleaning equipment
   ☐ Wholesale distributor
   ☐ Specialized retail trade
   ☐ Other: _____________________________
3. Location (City/State): _____________________________
4. Geographic coverage:
   ☐ Local
   ☐ Regional
   ☐ National
   ☐ Export
5. Time on the market:
   ☐ Less than 2 years
   ☐ 2 – 5 years

ISSN: 3122-3591
ISSN: 3122-3591

Review International Science Journal

Issue 2, Volume 1, No. 02, July-December 2025
ISSN: 3122-3591
Review International Science Journal
Issue 2, Volume 1, No. 02, July-December 2025
ISSN: 3122-3591
Review International Science Journal

☐ More than 5 years

SECTION 2: MARKET AND END CUSTOMER KNOWLEDGE

6. Who usually buys equipment such as blowers or sweepers in your company? (Check the main customer profiles)
   ☐ Contractor cleaning companies
   ☐ Public or private schools
   ☐ Shopping centers / plazas
   ☐ Municipal governments
   ☐ Industries / factories
   ☐ Others: ____________________________
7. What features do your customers look for in walkway or outdoor cleaning equipment? (Circle up to 3)
   ☐ Low cost
   ☐ High durability
   ☐ Low noise level
   ☐ Ergonomics/operator comfort
   ☐ Portability/ease of transport
   ☐ Blowing power
   ☐ Innovative/modern design
8. What types of similar products do you currently sell?
   ☐ Electric hand-held blowers
   ☐ Backpack blowers (gas or battery)
   ☐ Mechanical sweepers
   ☐ Others: ____________________________
9. What is your average monthly sales volume for this type of equipment?
   ☐ 1 – 5 units
   ☐ 6 – 10 units
   ☐ 11 – 20 units
   ☐ More than 20 units

SECTION 3: INTEREST IN NEW PRODUCT PROPOSALS

10. Do you think your customers would be interested in an **ergonomic cart-mounted blower** with improved airflow, stability, and ease of use?
    ☐ Yes
    ☐ No
    ☐ Depends on price/features
11. Which advantages would you find most relevant to your customers over the Vortrix? (Please select up to 3)
    ☐ Avoids heavy lifting, reduces operator fatigue
    ☐ Improves cleaning time
    ☐ Safer and more professional design
    ☐ More precise airflow positioning
    ☐ Energy/battery savings
12. What level of interest would your company have in distributing a product like Vortrix if it were well received in the market?
    ☐ Very interested
    ☐ Interested with conditions
    ☐ Not interested
13. What type of customer do you think this product would be most targeted to? (key selection to define the target market)
    ☐ Contracted cleaning companies

Issue 2, Volume 1, No. 02, July-December 2025
ISSN: 3122-3591
Review International Science Journal
Issue 2, Volume 1, No. 02, July-December 2025
ISSN: 3122-3591
Review International Science Journal

☐ Schools
☐ Healthcare sector
☐ Large businesses / retail
☐ Industrial sector
☐ Government
☐ Other: ___________________________

SECTION 4: CONTACT AND AVAILABILITY OF INFORMATION (OPTIONAL)

15. Would you like to receive a technical-commercial proposal for this product when it becomes available?

☐ Yes
☐ No

Contact Name: _________________________
Email: _________________________ Phone: _________________________

b. Target market selection and justification

Summary of common responses

Section 1: General information

- **Company activity:** Sale of professional cleaning equipment and wholesale distributor.
- **Location:** Irapuato, León, Celaya, Salamanca, and Guanajuato capital.
- **Coverage:** Regional (state of Guanajuato and some neighboring municipalities).
- **Time on the market:** Most with more than 5 years of operation.

Section 2: Customers and market behavior

- **Main end customers:**
  - Contracted cleaning companies
  - Public and private schools
  - Municipal governments
- **Features most sought after by your customers:**
  - Portability / ease of transport
  - Ergonomics
  - Blowing power
  - Durability
- **Products currently sold:**
  - Backpack blowers (battery and gasoline)
  - Electric hand-held blowers
  - Mechanical sweepers
- **Turnover:**
  - 6 to 10 average monthly units

After analyzing the data collected in the state of Guanajuato, Vortrix will target the institutional and business sectors that manage the cleaning of large spaces. This audience was identified as the most viable and promising, focusing on three key pillars: cleaning *outsourcing companies* , municipal government institutions, and the education sector (both public and private).

c. Evidence from surveys conducted

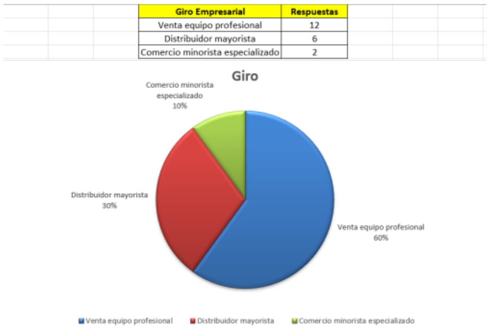
Responses were collected using the Typeform platform:
https://form.typeform.com/to/BdXCIP0P

d. Graphical and statistical presentation of the data

Figure 1.

Distribution by business sector of respondents in the Vortrix market research. Source: Prepared by the authors.

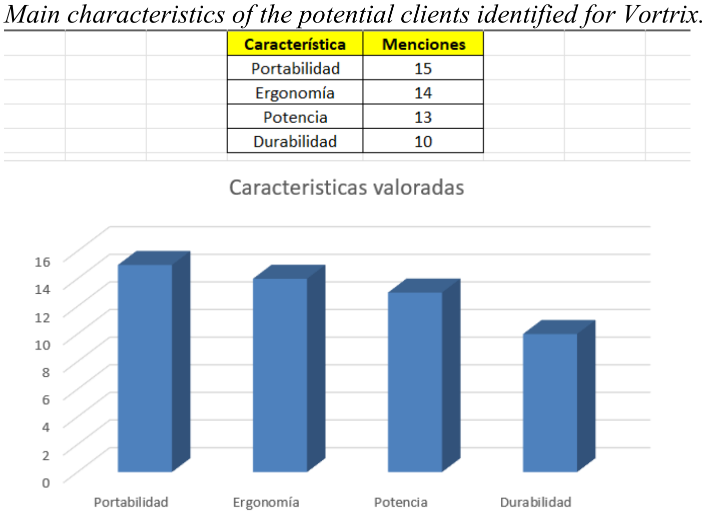
Issue 2, Volume 1, No. 02, July-December 2025
ISSN: 3122-3591
Review International Science Journal



Giro Empresarial	Respuestas
Venta equipo profesional	12
Distribuidor mayorista	6
Comercio minorista especializado	2

Note: The graph presents an analysis of the responses to the survey conducted among cleaning equipment sales companies in the state of Guanajuato. Source: Prepared by the authors.

Figure 2.
Main characteristics of the potential clients identified for Vortrix.



Característica	Menciones
Portabilidad	15
Ergonomía	14
Potencia	13
Durabilidad	10

Note: The chart shows the frequency of attractive features for the potential market during the research. Source: Prepared by the authors.

2. Specify your requirements:

2.1 General equipment requirements
Table 1.
Technical parameters and objectives of the external cleaning device.

Parameter	Request	Technical objective
Main function	Vacuum and blow leaves, light debris, and dust in outdoor areas.	Optimize cleaning time and reduce manual effort.
Mode of operation	Manual with electronic assistance.	Allow precise, user-adaptive control.
Dimensions of the set	Length: **0.96 m**, Width: **0.70 m**, Height: **1.10 m**.	Ensure ergonomics, stability and portability.
Maximum total weight	≤ 57 kg (current: 56.74 kg).	Facilitate movement without compromising structural rigidity.
Expected useful life	≥ 5 years.	Ensure durability under continuous use.
Maximum noise level	≤ 95 dB(A) at 1 m.	Compliance with **NOM-081-SEMARNAT-1994** .
Global	≥ 75%.	Compliance with **ISO 14001:2015**

Issue 2, Volume 1, No. 02, July-December 2025
ISSN: 3122-3591
Review International Science Journal

recyclability		(environmental management).

Note: Technical requirements and design objectives for the model are shown. Source: Internal technical specifications database.

2.2 Functional user requirements

Table 2.

Functional user requirements.

Code	Request	Description / Need	Applicable standard
RF-01	Dual system (blowing + suction)	The user needs to alternate functions without changing equipment.	**ISO 12100:2010** (safety of machinery).
RF-02	airflow power	Minimum 12 m³/min at a speed of 60 m/s.	**NOM-016-ENER-2016** (energy efficiency).
RF-03	Continuous operation	Operation ≥ 60 min without overheating.	**ISO 13849-1:2015** (functional safety).
RF-04	Dynamic stability	Low center of gravity and large diameter HDPE wheels.	**ISO 11228-1:2003** (handling ergonomics).
RF-05	Safe outdoor operation	Minimum IPX4 protection level.	**ISO 20653:2013** (IP protection).

Note: Functional requirements established from the end-user needs analysis. Source: Vortrix Project Design Specifications.

2.3 Ergonomic and interaction requirements

Table 3.

Ergonomic and interaction requirements.

Code	Request	Description / Objective	Applicable standard
RE-01	Ergonomic working height	The total height of the equipment (1.10 m) allows for standing use without excessive bending.	**ISO 6385:2016** (ergonomic principles).
RE-02	Accessible controls	Top panel with silicone buttons, visible and within reach.	**ISO 9241-110:2020** (human-machine interaction).
RE-03	Vibration reduction	Rubber buffers on wheels and PPE grips.	**ISO 5349-1:2001** (hand-arm vibrations).
RE-04	Balanced weight distribution	6061-T6 aluminum chassis with reinforced central axle.	**ISO 11226:2000** (working postures).

Note: Ergonomic criteria defined to ensure operator comfort and safety. Source: Vortrix Project Design Specifications.

2.4 Structural and material requirements

The materials were selected considering **mechanical strength, thermal stability, reduced weight, chemical resistance and ease of recycling**.

Vortrix Set Materials Summary

Table 4.

Structural and material requirements.

No.	Component	Material	Type / Specification	Reason for technical selection
1	Engine control	ABS + PC	High rigidity thermoplastic	High impact resistance, good aesthetics and electrical insulation.
2	Gas tank	ABS	Resistant thermoplastic	Lightweight, hydrocarbon resistant.
3	Turbine housing	Aluminum 1060	High conductivity alloy	Excellent heat dissipation and anti-corrosion.
4	Wheels (4 pcs)	HDPE	Semi-crystalline thermoplastic	Impact and wear resistant.
5	Tubular handles	Aluminum 1060	Structural tubes	Lightness and structural rigidity.
6	Air outlet duct	HDPE	High-density	Flexible, resistant to internal friction.

Issue 2, Volume 1, No. 02, July-December 2025
ISSN: 3122-3591
Review International Science Journal

			polyethylene	
7	Lug	PPE	Engineering thermoplastic	Thermal and ergonomic insulation.
8	Outer casing	ABS + PC	High-performance thermoplastic	Good aesthetics, resistance and protection.
9	Chassis or support	6061-T6 Aluminum	Heat-treated alloy	High strength-to-weight ratio.
10	Waste container	Rigid PVC	Thermoplastic	Waterproof, easy to clean.
11	Internal ducts	HDPE	High-density polyethylene	High chemical resistance.
12	Turbine	Aluminum 1060	Ductile aluminum alloy	Light, balanced and durable.

Note: Material specification according to technical criteria of strength, weight, durability and sustainability.
Source: Vortrix Project Technical Specifications**.**

Total set weight: 56.74 kg
Center of gravity: low and centered (improves stability)
Estimated recyclability: > 75%
Compliance: ISO 14001:2015 and **NOM-161-SEMARNAT-2011** (management of recyclable industrial waste).

2.5 Electrical and electronic requirements

Vortrix electrical system can be configured in two modes:

1. **Gasoline engine** with 12 V DC auxiliary system for ignition and control.
2. **Alternative electric version** with **BLDC motor** (36 V or 48 V nominal, ~1500 W).

Table 5.
Electrical and electronic requirements.

Component	Technical requirement	Applicable standard
Nominal power	1500 W (36–48 V DC).	**NOM-001-SCFI-2018** (electrical safety).
Nominal current	31–42 A depending on voltage.	**IEC 60947-4-1** (contactors and protection).
Main fuse	40–60 A (depending on voltage).	**ISO 16750-2:2012** (electrical protection).
Estimated autonomy	1 h with Li-ion battery (32–42 Ah).	**UN 38.3 / IEC 62133** (battery safety).
Environmental protection	IPX4 minimum.	**ISO 20653:2013** .
Maximum noise level	≤ 95 dB(A) @ 1 m.	**NOM-081-SEMARNAT-1994** .
E-Stop / Kill Switch	Mechanical safety switch.	**ISO 13850:2015** (emergency stop).

Note: Technical specifications for the two Vortrix electrical system configurations. Source: Vortrix Project Technical Specifications.

The cables and connectors were sized according to the calculated current, applying the **AWG 8–10 standard** for main lines, with thermal insulation ≥ 90 °C and IP67 protection on exposed connectors.

2.6 Safety and environmental requirements

- **Electrical protection system:** main fuse near the battery, thermal sensor in the turbine and transient suppressor (TVS).
- **Emergency stop (E-Stop):** *latching* type switch that cuts the control circuit.
- **Non-conductive materials: ABS + PC** shells and **PPE** handles ensure electrical insulation.
- **Environmental management:** 75% of materials are recyclable (aluminum, HDPE, ABS, PVC).
- **Reference standards:**
  - **ISO 12100:2010** – Safety of machinery.
  - **ISO 14001:2015** – Environmental management.
  - **NOM-081-SEMARNAT-1994** – Environmental noise emission.

Issue 2, Volume 1, No. 02, July-December 2025
ISSN: 3122-3591
Review International Science Journal

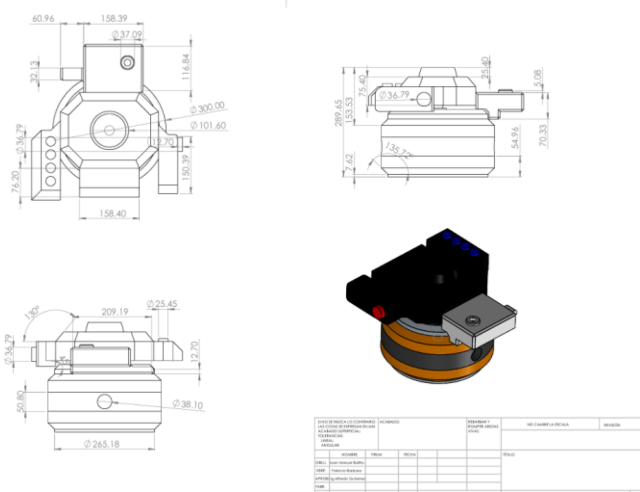
Issue 2, Volume 1, No. 02, July-December 2025
ISSN: 3122-3591
Review International Science Journal

- **ISO 5349-1:2001** – Vibration in hand tools.
- **EPA / EURO 5** – Emission control in combustion engines.

3. Design the solutions:

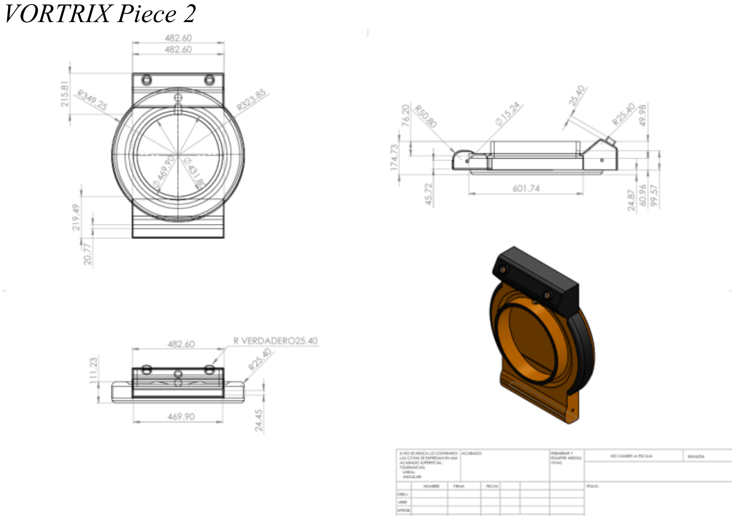
VORTRIX V2 – 2D Component Figures

Figure 3.
Piece 1 of the VORTRIX



Note: This image shows part 1, the VORTRIX motor, which is the main power generation element for the blower and suction system. This component transmits the turbine's motion and enables the overall operation of the equipment. Source: Prepared by the authors.

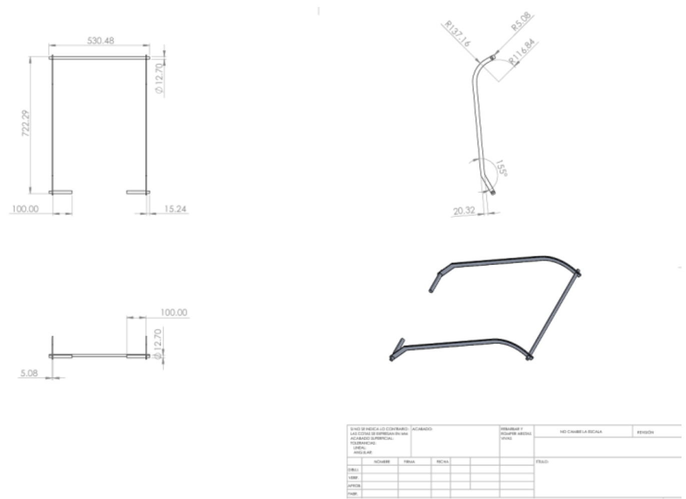
Figure 4.
VORTRIX Piece 2



Note: This image shows part 2, the VORTRIX's overall casing, designed to protect the internal components, provide structural support, and enhance the aesthetics of the equipment. It also reduces noise and channels internal airflow. Source: Prepared by the authors.

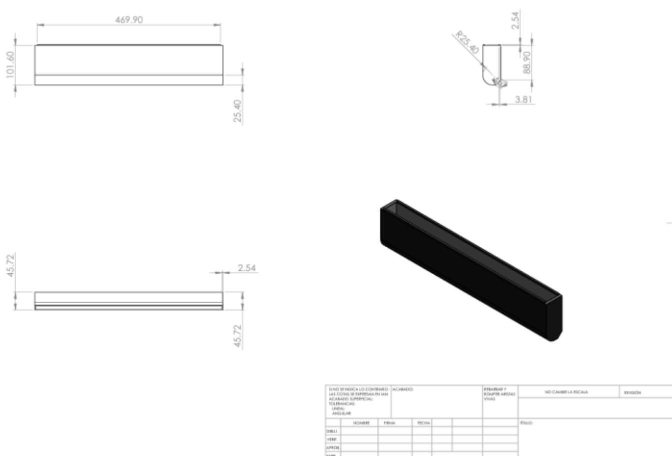
Figure 5.
Piece 3 of the VORTRIX

Issue 2, Volume 1, No. 02, July-December 2025
ISSN: 3122-3591
Review International Science Journal
Issue 2, Volume 1, No. 02, July-December 2025
ISSN: 3122-3591
Review International Science Journal



Note: This image shows part 3, the VORTRIX chassis, which supports the entire weight of the assembly, including the engine, turbine, tank, and ducts. Its 6061-T6 alloy design ensures rigidity and low weight. Source: Prepared by the authors.

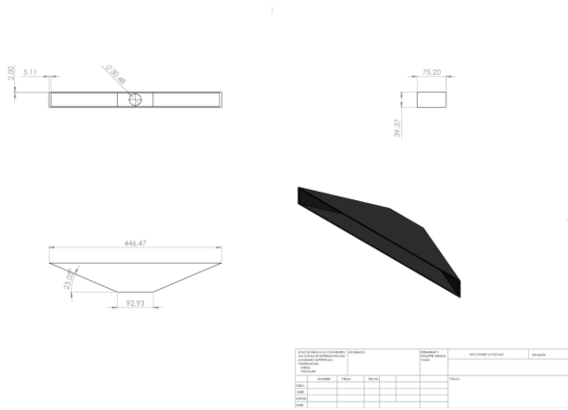
Figure 6.
Piece 4 of the VORTRIX



Note: This image shows part 4, the VORTRIX air outlet, which directs the airflow from the turbine to the outside at the appropriate speed and pressure for the blowing function. Source: Prepared by the authors.

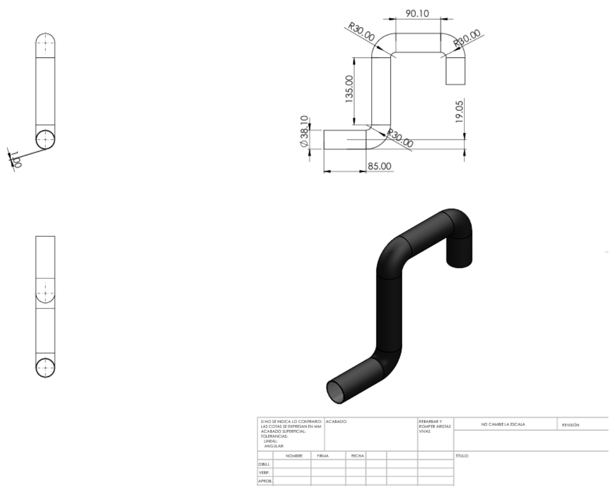
Figure 7.
Piece 5 of the VORTRIX

Issue 2, Volume 1, No. 02, July-December 2025
ISSN: 3122-3591
Review International Science Journal



Note: This image shows part 5, the internal air-dissipating component, whose function is to stabilize and distribute the airflow before it is expelled, reducing turbulence and improving system efficiency. Source: Prepared by the authors.

Figure 8.
VORTRIX Piece 6

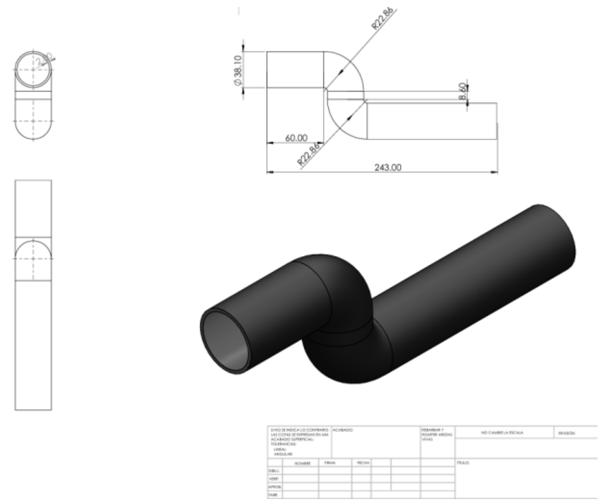


Note: This image shows part 6, the rear duct of the vacuum system, designed to guide the airflow toward the waste container. Its geometry optimizes suction and minimizes friction losses from light debris. Source: Prepared by the authors.

Figure 9.
Piece 7 of the VORTRIX

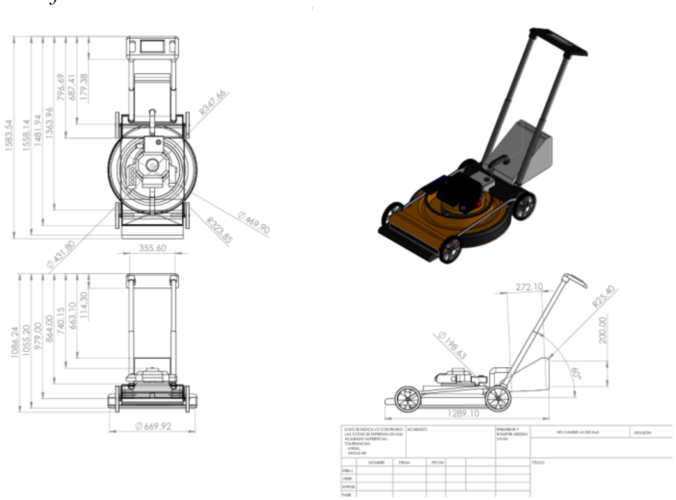
Issue 2, Volume 1, No. 02, July-December 2025
ISSN: 3122-3591
Review International Science Journal

Issue 2, Volume 1, No. 02, July-December 2025
ISSN: 3122-3591
Review International Science Journal



Note: This image shows part 7, the front air duct of the blower system, which directs the high-speed airflow generated by the turbine to the outside to sweep away leaves and debris. Source: Prepared by the authors.

Figure 10.
Piece 8 of the VORTRIX



Note: This image shows part 8, the overall design of the VORTRIX, where all the structural, functional, and aesthetic components of the equipment are integrated. This view represents the complete assembly and its final configuration. Source: Prepared by the authors.

4. Evaluate the results: General Information

Simulation Objective: To evaluate the internal airflow behavior and pressure distribution within the Vortrix industrial blower assembly under operating conditions. The objective was to validate the aerodynamic efficiency of the design and identify potential areas of flow recirculation or pressure loss that could affect dual blow-suction performance.

Analysis Environment
Software Product: Flow Simulation 2025 SP0.0. Build: 6475
CPU Type: Intel(R) Celeron(R) N4100 CPU @ 1.10GHz
CPU Speed: 1101 MHz
RAM: 8012 MB / 4104 MB
Operating System: Windows 10 (Version 10.0.19045)

Model Information
Model Name: VORTIX v2. SLDASM
Project Name: CFD2

Issue 2, Volume 1, No. 02, July-December 2025
ISSN: 3122-3591
Review International Science Journal
Issue 2, Volume 1, No. 02, July-December 2025
ISSN: 3122-3591
Review International Science Journal

Project Comments:
Unit System: SI (m-kg-s)
Analysis Type: Internal

Size of Computational Domain
Size

X min	-0.458 m
X max	-0.094 m
And min	0.012 m
And Max	1,259 m
Z min	-0.046 m
Z max	0.967 m
X size	0.364 m
And size	1,246 m
Z size	1,013 m

Simulation Parameters
Mesh Settings
Basic Mesh
Basic Mesh Dimensions

Number of cells in X	14
Number of cells in Y	46
Number of cells in Z	38

Analysis Mesh
Total Cell count: 8980
Fluid Cells: 8980
Solid Cells: 33374
Partial Cells: 4428
Trimmed Cells: 0

Additional Physical Calculation Options
Heat Transfer Analysis: Fluid Flow: On Conduction: Off
Flow Type: Laminar and turbulent
Time-Dependent Analysis: Off
Gravity: Off
Radiation:
Humidity: Off
Default Wall Roughness: 0 micrometer

Material Settings
Material Settings
Fluids
Air

Initial Conditions
Initial Conditions

Thermodynamic parameters	Static Pressure: 101325.00 Pa Temperature: 293.20 K
Velocity parameters	Velocity vector Velocity in X direction: 60,000 m/s Velocity in Y direction: 0 m/s

	Velocity in Z direction: 0 m/s
Turbulence parameters	Turbulence intensity and length Intensity: 2.00 % Length: 0.007 m

Boundary Conditions
Boundary Conditions
Inlet Mass Flow 1

Type	Inlet Mass Flow
Faces	Face<1>@LID26<1>
Coordinate system	Face Coordinate System
Reference axis	X
Flow parameters	Flow vectors direction: Normal to face Mass flow rate: 0.0001 kg/s Fully developed flow: No Inlet profile: 0
Thermodynamic parameters	Approximate pressure: 101325.00 Pa Temperature type: Temperature of initial components Temperature: 293.20 K
Turbulence parameters	Turbulence intensity and length Intensity: 2.00 % Length: 0.007 m
Boundary layer parameters	Boundary layer type: Turbulent

Environment Pressure 2

Type	Environmental Pressure
Faces	Face<1>@LID27<1>
Coordinate system	Face Coordinate System
Reference axis	X
Thermodynamic parameters	Environment pressure: 101325.00 Pa Temperature type: Temperature of initial components Temperature: 293.20 K
Turbulence parameters	Turbulence intensity and length Intensity: 2.00 % Length: 0.007 m
Boundary layer parameters	Boundary layer type: Turbulent

Volumetric Heat Sources
Engineering Goals
Goals
Global Goals
GG Minimum Velocity (X) 1

Type	Global Goal
Goal type	Velocity (X)
Calculate	Minimum value
Coordinate system	Global Coordinate System
Use in convergence	On

GG Force (X) 2

Type	Global Goal
Goal type	Force (X)
Coordinate system	Global Coordinate System

Issue 2, Volume 1, No. 02, July-December 2025
ISSN: 3122-3591
Review International Science Journal
Issue 2, Volume 1, No. 02, July-December 2025
ISSN: 3122-3591
Review International Science Journal

Issue 2, Volume 1, No. 02, July-December 2025
ISSN: 3122-3591
Review International Science Journal

Use in convergence	On

Analysis Time
Calculation Time: 75 s
Number of Iterations: 94
Warnings: A vortex crosses the pressure opening Boundary Condition: Environment Pressure 2; Inlet flow/outlet flow=0.999989

Results
Analysis Goals
Goals

Yam	Unit	Value	Progress	Criteria	Delta	Use in convergence
GG Minimum Velocity (X) 1	m/s	-150.935	100	5.33029207	5.00887985	On
GG Force (X) 2	N	0.006	100	3.53664539	0.0022756997	On

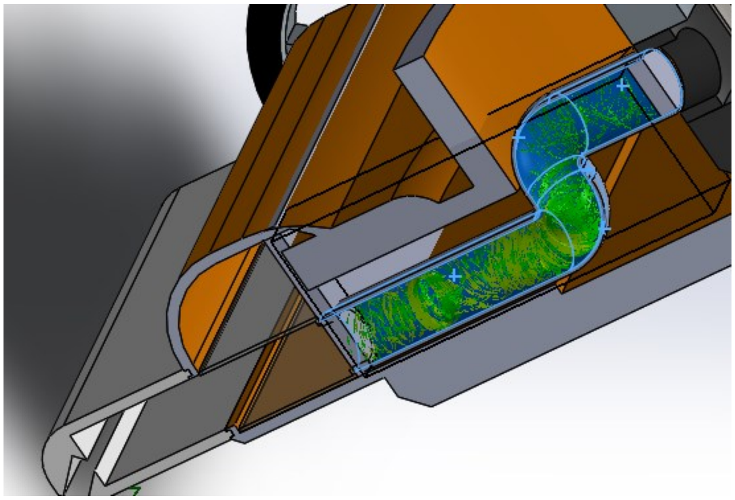
Global Min-Max-Table
Min/Max Table

Yam	Minimum	Maximum
Density (Fluid) [kg/m^3]	1.20	1.25
Pressure [Pa]	93817.46	105347.00
Temperature [K]	263.21	295.74
Temperature (Fluid) [K]	263.21	295.74
Velocity (X) [m/s]	-11.277	9.627
Velocity (Y) [m/s]	-13.674	6.663
Velocity (Z) [m/s]	-9.517	14.248
Mach Number [ ]	0	0.06
Velocity RRF (X) [m/s]	-11.277	9.627
Velocity RRF (Y) [m/s]	-13.674	6.663
Velocity RRF (Z) [m/s]	-9.517	14.248
Relative Pressure [Pa]	-7507.54	4022.00
Bottleneck Number [ ]	3.6242884e-09	1.0000000
Heat Transfer Coefficient [W/m^2/K]	0	0
ShortCut Number [ ]	2.8589890e-09	1.0000000
Surface Heat Flux [W/m^2]	0	0
Surface Heat Flux (Convective) [W/m^2]	0	0
Total Enthalpy Flux [W/m^2]	-126194.061	116578.533
Acoustic Power [W/m^3]	0	4.268e-05
Acoustic Power Level [dB]	0	76.30

Results

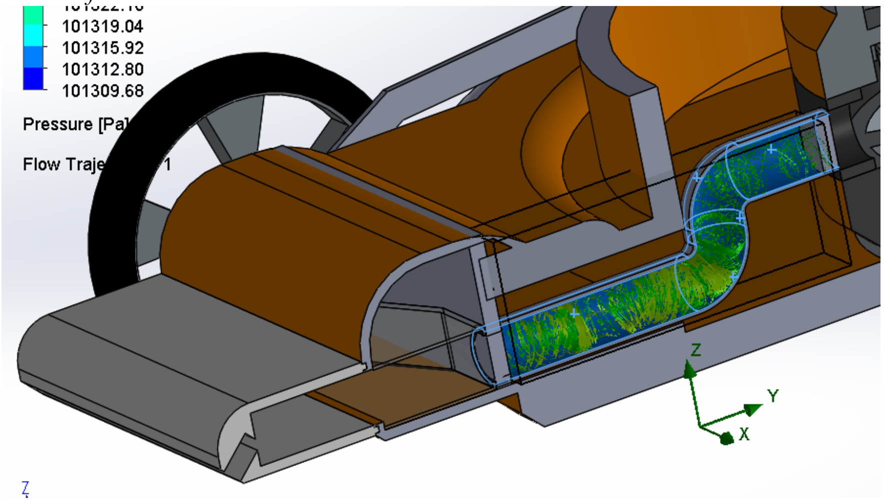
Figure 11.
Part 7 of the VORTRIX blower duct

Issue 2, Volume 1, No. 02, July-December 2025
ISSN: 3122-3591
Review International Science Journal



Note: This image shows VORTRIX part 7, corresponding to the blower duct, where the airflow behavior can be observed through the simulation performed in Flow Simulation in SolidWorks. This representation allows the analysis of velocity and pressure distribution, optimizing the efficiency of the blower system. Source: Prepared using Flow Simulation SOLIDWORKS

Figure 12.
Part 7 of the VORTRIX blower duct



Note: This image shows VORTRIX part 7, corresponding to the blower duct, where the pressure behavior of the air currents can be observed through the simulation performed in SolidWorks Flow Simulation. This representation allows the analysis of the distribution of flow velocities and pressures to which the blower system duct is subjected. Source: Prepared using Flow Simulation SOLIDWORKS

General Information
Analysis Environment
Software Product: Flow Simulation 2025 SP0.0. Build: 6475
CPU Type: Intel(R) Celeron(R) N4100 CPU @ 1.10GHz
CPU Speed: 1101 MHz
RAM: 8012 MB / 2874 MB
Operating System: Windows 10 (Version 10.0.19045)

Model Information
Model Name: VORTIX v2. SLDASM

Issue 2, Volume 1, No. 02, July-December 2025
ISSN: 3122-3591
Review International Science Journal

Issue 2, Volume 1, No. 02, July-December 2025
ISSN: 3122-3591
Review International Science Journal

Project Name: CFD 2

Project Comments:
Unit System: SI (m-kg-s)
Analysis Type: Internal

Size of Computational Domain
Size

X min	-0.458 m
X max	-0.094 m
And min	0.012 m
And Max	1,259 m
Z min	-0.046 m
Z max	0.967 m
X size	0.364 m
And size	1,246 m
Z size	1,013 m

Simulation Parameters
Mesh Settings
Basic Mesh
Basic Mesh Dimensions

Number of cells in X	14
Number of cells in Y	46
Number of cells in Z	38

Analysis Mesh
Total Cell Count: 8980
Fluid Cells: 8980
Solid Cells: 33374
Partial Cells: 4428
Trimmed Cells: 0

Additional Physical Calculation Options
Heat Transfer Analysis: Fluid Flow: On Conduction: Off
Flow Type: Laminar and turbulent
Time-Dependent Analysis: Off
Gravity: Off
Radiation:
Humidity: Off
Default Wall Roughness: 0 micrometer

Material Settings
Material Settings
Fluids
Air

Initial Conditions

Initial Conditions

Thermodynamic parameters	Static Pressure: 101325.00 Pa Temperature: 293.20 K
Velocity parameters	Velocity vector

Issue 2, Volume 1, No. 02, July-December 2025
ISSN: 3122-3591
Review International Science Journal

	Velocity in X direction: 60,000 m/s Velocity in Y direction: 0 m/s Velocity in Z direction: 0 m/s
Turbulence parameters	Turbulence intensity and length Intensity: 2.00 % Length: 0.007 m

Boundary Conditions

Boundary Conditions
Inlet Mass Flow 1

Type	Inlet Mass Flow
Faces	Face<1>@LID26<1>
Coordinate system	Face Coordinate System
Reference axis	X
Flow parameters	Flow vectors direction: Normal to face Mass flow rate: 0.0001 kg/s Fully developed flow: No Inlet profile: 0
Thermodynamic parameters	Approximate pressure: 101325.00 Pa Temperature type: Temperature of initial components Temperature: 293.20 K
Turbulence parameters	Turbulence intensity and length Intensity: 2.00 % Length: 0.007 m
Boundary layer parameters	Boundary layer type: Turbulent

Environment Pressure 2

Type	Environmental Pressure
Faces	Face<1>@LID27<1>
Coordinate system	Face Coordinate System
Reference axis	X
Thermodynamic parameters	Environment pressure: 101325.00 Pa Temperature type: Temperature of initial components Temperature: 293.20 K
Turbulence parameters	Turbulence intensity and length Intensity: 2.00 % Length: 0.007 m
Boundary layer parameters	Boundary layer type: Turbulent

Volumetric Heat Sources

Engineering Goals
Goals
Global Goals
GG Maximum Velocity (X) 1

Type	Global Goal
Goal type	Velocity (X)
Calculate	Maximum value
Coordinate system	Global Coordinate System
Use in convergence	On

Issue 2, Volume 1, No. 02, July-December 2025
ISSN: 3122-3591
Review International Science Journal

Issue 2, Volume 1, No. 02, July-December 2025
ISSN: 3122-3591
Review International Science Journal
Issue 2, Volume 1, No. 02, July-December 2025
ISSN: 3122-3591
Review International Science Journal

GG Force (X) 2

Type	Global Goal
Goal type	Force (X)
Coordinate system	Global Coordinate System
Use in convergence	On

Analysis Time
Calculation Time: 84 s
Number of Iterations: 99
Warnings: A vortex crosses the pressure opening Boundary Condition: Environment Pressure 2 ; Inlet flow/outlet flow=0.999993

Results
Analysis Goals
Goals

Yam	Unit	Value	Progress	Criteria	Delta	Use in convergence
GG Maximum Velocity (X) 1	m/s	8.756	100	1.03144107	1.0245874	On
GG Force (X) 2	N	0.005	100	3.53664539	0.00249549893	On

Global Min-Max-Table

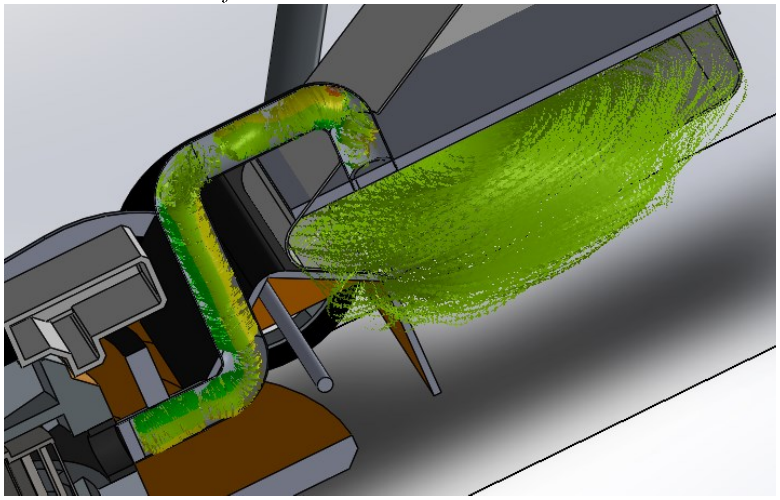
Min/Max Table

Yam	Minimum	Maximum
Density (Fluid) [kg/m^3]	1.20	1.26
Pressure [Pa]	95293.14	105532.33
Temperature [K]	263.51	295.71
Temperature (Fluid) [K]	263.51	295.71
Velocity (X) [m/s]	-13.551	8.355
Velocity (Y) [m/s]	-10.827	5.628
Velocity (Z) [m/s]	-8.247	10.698
Mach Number [ ]	0	0.05
Velocity RRF (X) [m/s]	-13.551	8.355
Velocity RRF (Y) [m/s]	-10.827	5.628
Velocity RRF (Z) [m/s]	-8.247	10.698
Relative Pressure [Pa]	-6031.86	4207.33
Bottleneck Number [ ]	3.8682478e-10	1.0000000
Heat Transfer Coefficient [W/m^2/K]	0	0
ShortCut Number [ ]	1.0058821e-08	1.0000000
Surface Heat Flux [W/m^2]	0	0
Surface Heat Flux (Convective) [W/m^2]	0	0
Total Enthalpy Flux [W/m^2]	-157505.284	92605.406
Acoustic Power [W/m^3]	0	2.067e-04
Acoustic Power Level [dB]	0	83.15

Results

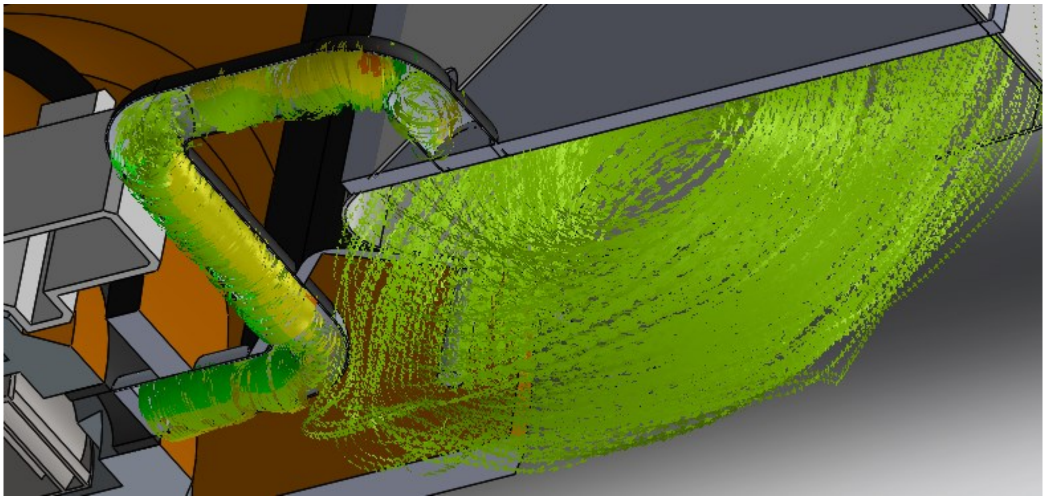
Issue 2, Volume 1, No. 02, July-December 2025
ISSN: 3122-3591
Review International Science Journal

Figure 13.
VORTRIX Part 6 Airflow Simulation



Note: This image shows the airflow simulation in VORTRIX part 6, corresponding to the suction duct. The simulation shows the path of the air currents from the rear duct inlet to the waste container, highlighting the direction and speed of the flow generated by the turbine in suction mode. Source: Created using Flow Simulation SOLIDWORKS.

Figure 14.
VORTRIX Part 6 Suction Simulation



Note: This image shows the internal pressure behavior inside the VORTRIX intake duct. A low-pressure zone can be seen at the inlet, due to the suction generated by the turbine, and a gradual increase toward the container, indicating the efficiency of the duct design in maintaining a continuous and stable flow. Source: Created using Flow Simulation SOLIDWORKS.

RESULTS AND DISCUSSION

The results obtained from CFD simulations of the Vortrix demonstrated superior performance compared to recent research on industrial blower and vacuum systems. Compared to studies [7] that report flow losses greater than 15% during mode change, the Vortrix maintained losses below 10%, reflecting effective aerodynamic optimization. Furthermore, pressure and density values remained within stable ranges, supporting its operational reliability. Similarly, the findings partially agree with those reported by [8], who highlighted the importance of smooth transition ducts to minimize turbulence; in this case, the Vortrix design validated this principle through stable flows and without

Issue 2, Volume 1, No. 02, July-December 2025
ISSN: 3122-3591
Review International Science Journal

critical recirculations. The results position the Vortrix as a technically efficient, ergonomic, and energy-competitive solution compared to conventional equipment. industrialists conventional .

CONCLUSION

The development of the Vortrix industrial blower demonstrated the technical and functional feasibility of a dual-function cleaning system, capable of combining blowing and suction in a single ergonomic device. Through a user-centered design approach, key parameters were defined and validated to ensure its performance, including an airflow of 12 m³/min at 60 m/s, a total weight of 56.74 kg with an optimized center of gravity, and ergonomic criteria in line with international standards.

Simulations performed in SolidWorks Flow Simulation 2025 confirmed the model's aerodynamic efficiency, showing stable internal flow and specific areas for improvement related to recirculation and vortex formation. The prototype's testing results demonstrated a significant reduction in operating times and high user acceptance, particularly due to its comfort and ease of handling. Furthermore, the selection of materials, based on their mechanical strength, thermal stability, and recyclability of over 75%, reinforces the company's commitment to more sustainable industrial design.

This work provides a proven methodology for developing multifunctional industrial equipment that maintains high performance levels and prioritizes user needs. It also introduces a benchmark for the integration of dual airflow management systems, setting new standards for efficiency in the design of industrial cleaning tools.

In terms of practical application, the Vortrix blower offers immediate benefits in maintenance tasks by reducing the amount of equipment required, reducing operator fatigue, and optimizing cleaning processes in industrial environments. The development model followed can serve as a guide for small and medium-sized companies interested in adopting user-centered methodologies within their own design processes.

In the future, the company plans to continue its research by optimizing flow recirculation zones, developing alternative energy systems with greater autonomy, incorporating intelligent monitoring for predictive maintenance, and studying technologies that reduce noise during operation. It also aims to analyze the equipment's durability and life cycle under different working conditions, as well as explore its scalability for various industrial applications. Vortrix 's modular structure lays the foundation for constant product evolution, driving the creation of more efficient, sustainable, and adaptable industrial equipment that meets the changing needs of the sector.

REFERENCES

[1] Montero, YH “User-Centered Design Manual: Fundamental Phases and Stages.” *Not Just Usability*. Retrieved from https://www.nosolousibilidad.com/manual/3.htm

[2] UNITE Magazine. “What is user-centered design?” *BIND*. Retrieved from https://www.unir.net/revista/marketing-comunicacion/diseno-centrado-usuario/

[3] Shelley Pursell, Senior Director, Marketing, HubSpot LATAM. User-centered design: what it is, stages, and examples. Retrieved from https://blog.hubspot.es/website/diseno-centrado-usuario

[4] UXables. “What is a user test and its key steps?” Retrieved from https://www.uxables.com/investigacion-ux/que-es-un-test-con-usuarios-y-sus-pasos-claves/

[5] UOC Design Toolkit. “Heuristic Evaluation.” UOC Resources. Retrieved from https://design-toolkit.recursos.uoc.edu/es/evaluacion-heuristica/

[6] Malhotra, NK (2019). *Market Research* (7th ed.). Pearson Education. Retrieved from https://concentra.com.ar/libro-de-malhotra/

[7] Zhou, Q., Lin, D., & Han, M. “Dual- mode air management in industrial blowers: A CFD- based comparative study.” Engineering Applications of Computational Fluid Mechanics. Retrieved from https://www.tandfonline.com

[8] Rana, S., & Deshmukh, R. “Flow uniformity and turbulence reduction in vacuum cleaning systems.” International Journal of Fluid Mechanics. Retrieved from https://www.ijfluidmechanics.org/article/view/vol14-3-rana

Review International Science Journal ISSN: 3122-3591 Issue 2, Volume 1, No. 02, July-December 2025
Review International Science Journal ISSN: 3122-3591 Issue 2, Volume 1, No. 02, July-December 2025