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# Thermal and Structural Analysis of an Electronic Cooling Fan using CATIA and ANSYS

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**ABSTRACT:**The thermal and structural management of electronic devices is crucial for maintaining optimal performance and reliability. This project focuses on the thermal analysis of an electronic cooling fan using CATIA for design and subsequent analysis. The project begins with the comprehensive design of the cooling fan using CATIA, considering factors such as airflow dynamics, geometry optimization and material selection.

The intricate modelling capabilities of CATIA ensure precise representation of the fan's components, facilitating efficient heat dissipation. Model of 4, 6 & 8 Nos blade design made, Subsequently, the cooling fan undergoes thermal analysis using advanced analysis techniques to simulate its performance under various operating conditions. Finite Element Analysis (FEA) is employed to assess temperature distribution, thermal gradients, and heat transfer efficiency within the fan assembly. By Varying Materials like Carbon Fiber & Kevlar Fiber .The results of the thermal and static analysis provide valuable insights into the fan's thermal and structural behaviour, aiding in the identification of potential hotspots and optimization with material change.

**KEYWORDS:**Electronic cooling fan, Thermal analysis, Airflow dynamics, Geometry optimization, Finite Element Analysis, CATIA.

## INTRODUCTION

Industrial electronic cooling fans are integral to maintaining optimal operating temperatures for various electronic devices and equipment across industries. They are crucial components in applications like computers, HVAC systems, and thermal energy equipment, where efficient heat dissipation is essential to prevent overheating and ensure reliable performance. Despite their widespread use, there is still a need for a deeper understanding of electronic cooling fan systems, particularly in terms of thermal analysis and optimization.

This project focuses on conducting thermal analysis of electronic cooling fans using CATIA for design and subsequent analysis. By leveraging advanced modeling and simulation techniques, the study aims to enhance understanding of the thermal behavior and performance characteristics of electronic cooling fans under different operating conditions. Investigating the thermal dynamics of cooling fan systems is crucial for optimizing their performance, reliability, and



longevity. Through the utilization of CATIA for design and analysis, this project seeks to contribute to the advancement of electronic cooling fan technology, ultimately leading to more efficient and reliable cooling solutions for a wide range of industrial applications.

## II. RELATED WORK

In paper titled “CFD Thermal Analysis on Laptop Cooling System Using Loop Heat Pipe Technology”, Mr. Ravikiran Chinthalapudi shows that Science and technology have begun a new era in the history of humanity. As a result of technology progress, electronic devices have become smaller, lighter and faster, especially laptops. Laptops are subjected to a lot of heat for high process units, which cause high spots on the processing unit. Because the current cooling system is weak for heat dissipation in warm locations, the trendy MLHP heat pipe technology is upgraded for better cooling. As a method to improve performance in the propulsion systems of UAVs, two topics of interest are emphasized in this: the potential improvements offered by ducted propellers and the relatively uninvestigated performance of small-scale rotors. Compared with current active cooling technologies, this novel passive cooling solution also provides various benefits such as noise free operation, lower energy usage and increased reliability. This article offers a visual depiction of a new laptop cooling solution and evaluates Fluent’s approach for the victimization of fluid dynamics. This test has varying thermal reductions 30W, 32W, 43W under various operating situations, such as regular laptop usage, normal usage, while battery charge and 100% mainframe load are heavily charged. Explained in the paper “Laptop cooling numerical simulation using Computational Fluid Dynamics” that laptop’s cooling solution is very important.

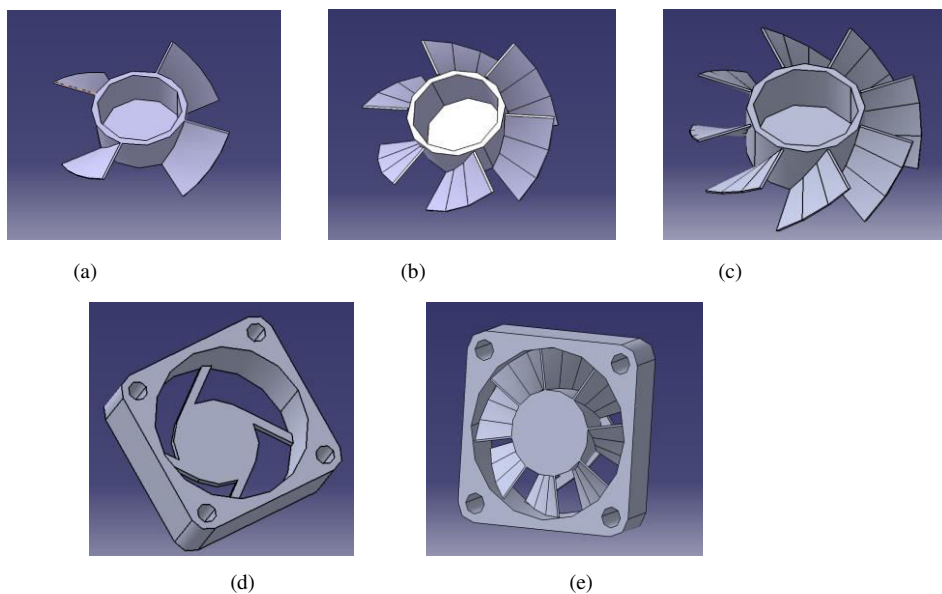
## III. METHODOLOGY

For conducting thermal and structural analysis of an electronic cooling fan involves a systematic approach using CATIA and ANSYS software. Firstly, the problem is defined, and objectives are set, specifying the parameters to investigate. Next, a detailed 3D model of the cooling fan assembly is created in CATIA, including all relevant components. Following this, a finite element mesh is generated to facilitate simulations in ANSYS, optimizing mesh density for accuracy. Material properties are assigned to each component, accounting for thermal and mechanical behavior. Boundary conditions, including thermal and mechanical loads, are defined for the analysis. Thermal analysis in ANSYS simulates heat transfer within the assembly, evaluating temperature distributions and heat dissipation. Structural analysis of an electronic cooling fan.

Material	Units	Carbon Fiber	Kevlar Fiber
Density	kg/m <sup>3</sup>	2000	1440
Young's Modulus	Gpa	181	130
Poisson ratio	-	0.28	0.44
Thermal Conductivity	W/m k	2.98	4.97

## IV. CAD MODELLING

Fig1: Catia Modelling (a) 4 blades fan propeller (b) 6 blades fan propeller (c) 8 blades fan propeller (d) fan casing (e) Complete electronic cooling fan



V. EXPERIMENTAL RESULTS

Fig. 2. Thermal and structural analysis of 4blades propeller (a)Ansys model (b) Image after applying meshing set of model (c) Image after applying second set of temperature distribution (d) Heat flux(e) deformation of model

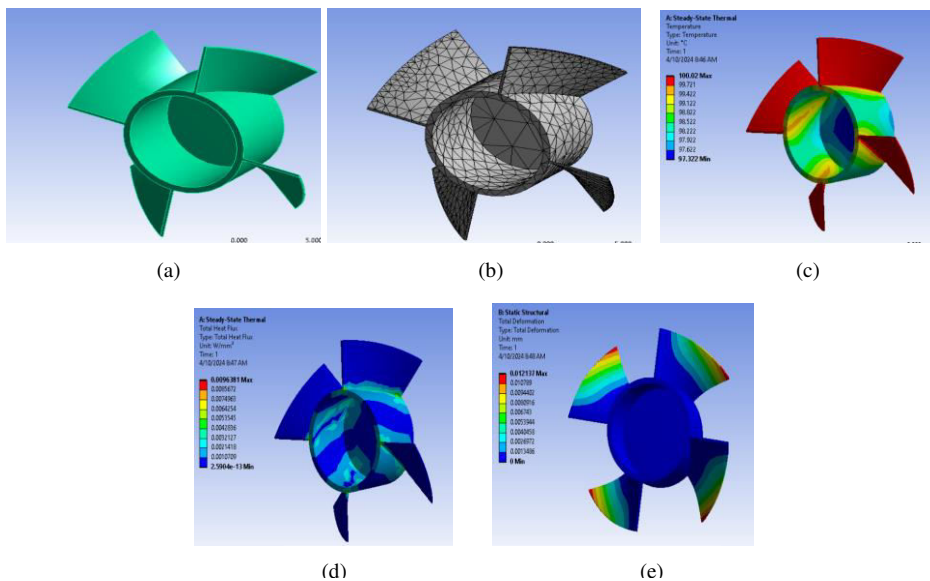
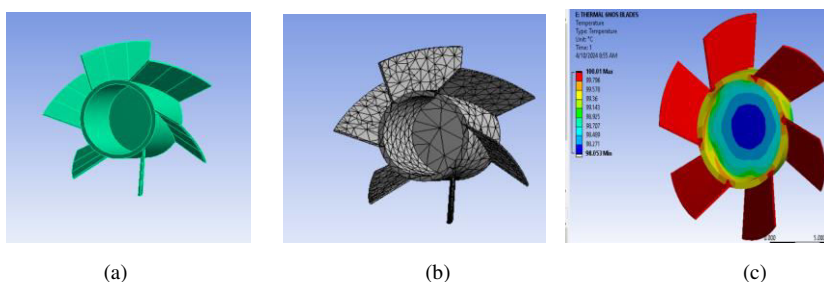


Fig. 3 Thermal and structural analysis of 6blades propeller (a)Ansys model (b) Image after applying meshing set of model (c) Image after applying second set of temperature distribution (d) Heat flux(e) deformation of model



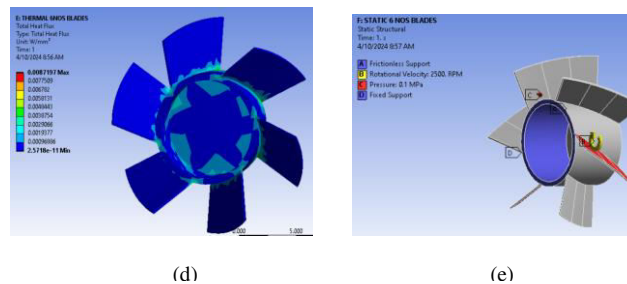
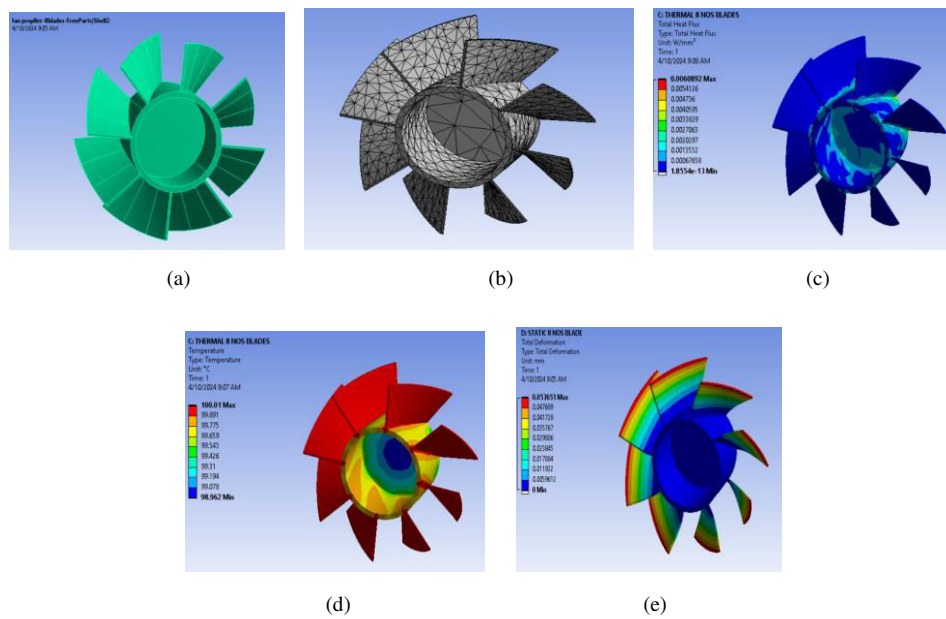


Fig. 4 Thermal and structural analysis of 8 blades propeller (a) Ansys model (b) Image after applying meshing set of model (c) Image after applying second set of temperature distribution (d) Heat flux (e) deformation of model

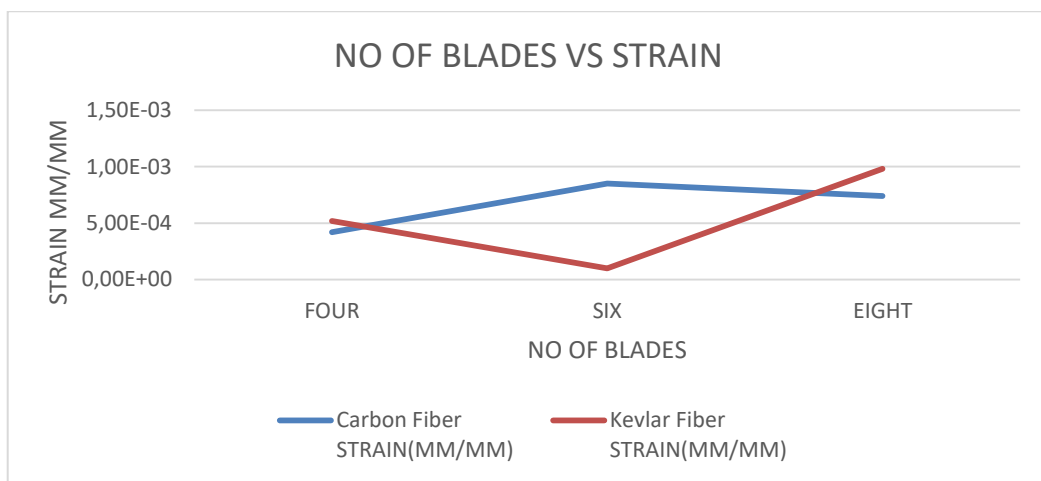
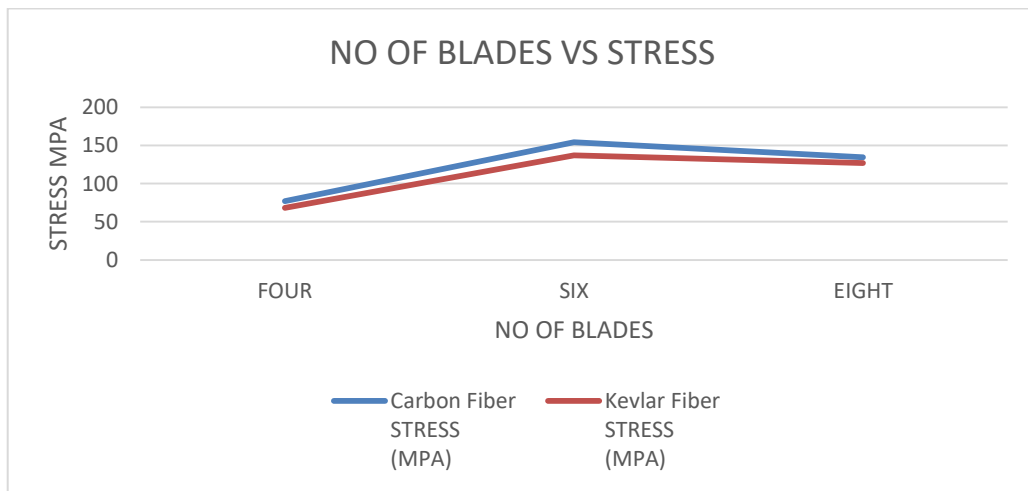
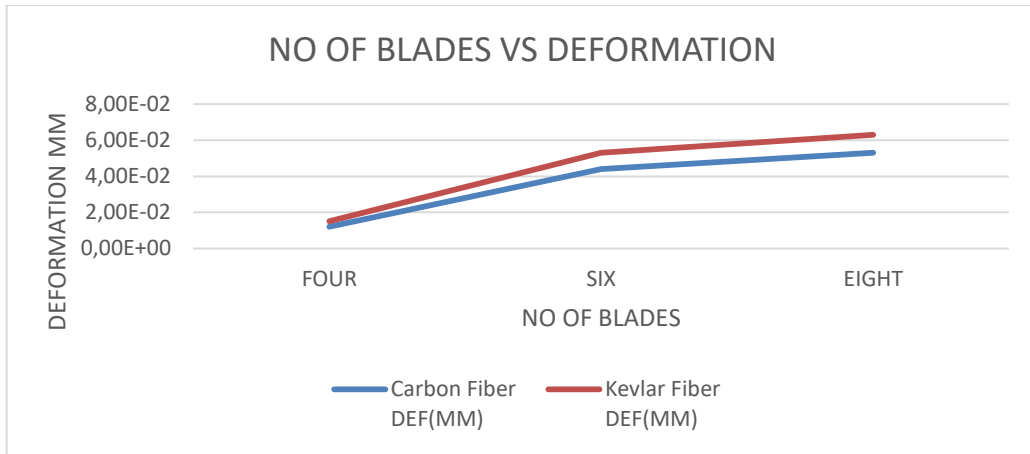


Tablular form:

4 NOS BLADES						
SNO	MATERIAL	TEMP	HEAT FLUX (W/MM2)	DEF(MM)	STRESS	STRAIN
	Carbon Fiber	100	9.60E-03	1.20E-02	77.21	4.20E-04
	Kevlar Fiber	100	9.70E-03	1.50E-02	68.09	5.20E-04

6 NOS BLADES						
SNO	MATERIAL	TEMP	HEAT FLUX	DEF	STRESS	STRAIN
	Carbon Fiber	100	8.70E-03	4.40E-02	154.12	8.50E-04
	Kevlar Fiber	100	8.70E-03	5.30E-02	137.17	1.00E-04

8 NOS BLADES						
SNO	MATERIAL	TEMP	HEAT FLUX	DEF	STRESS	STRAIN
	Carbon Fiber	100	6.00E-03	5.30E-02	134.35	7.40E-04
	Kevlar Fiber	100	6.00E-03	6.30E-02	126.81	9.80E-04



## VI. CONCLUSION

Our analysis studies is an Exhaust fan used in CPU performance analysis based on structural & thermal analysis in Ansys software. To predict the different blade nos 4,6 & 8nos and materials -carbon fiber and Kevlar Fiber used in an exhaust fan to the above analysis, choose the suitable material for Kevlar Fiber material. With the given speed of blade 120RPM and Temp 1000 C, with blade nos change. Profile with 8 nos and material Kevlar Fiber is has best for thermal and static load condition.

From the viewpoint of the Thermal Management, which controls temperature and humidity for cooling purposes in an integrated manner, probable issues in High temperature environments and their countermeasures were explained in this project. By appropriately incorporating Oriental Motor's thermal management products, customers' equipment can be used in various environments, and as a result, overall performance and reliability of the equipment will be improved.

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