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THESIS SUMMARY

CONTRIBUTIONS TO IMPROVING THE QUALITY OF COMPLEX PROFILE STRUCTURES USING ADVANCED TECHNICAL SYSTEMS

Scientific coordinator,

Prof. Eng. & Ec. Aurel Mihail ȚÎȚU, Ph.D & Sc.D

2024

CONTENT OF THE DOCTORAL THESIS

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The summary of the doctoral thesis includes only a short rendering of the most relevant information contained in the thesis. (The author)

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FOREWORD

In the contemporary context of accelerated technological development, the quality of complex structural designs becomes an essential element for safety and operational efficiency, especially in the field of aviation. This doctoral thesis addresses the issue of improving the quality of these structures through the use of advanced technical systems, offering a significant contribution to the field of aeronautical engineering.

This work is part of a broad and rigorous scientific endeavor, being the result of years of intense research and in-depth analysis. The main objective of this work is to identify and apply innovative technical solutions that enhance the performance and reliability of complex-shaped structural designs. These structures, due to their complexity, require an integrated approach that combines traditional engineering methods with modern technologies to meet the high standards imposed by the aerospace industry.

This work would not have been possible without the support and guidance of Professor Dr. Ing. and Dr. Ec. Habil. Aurel Mihail Țîțu, whose expertise and vision guided the entire research process. He was not only a scientific advisor but also a mentor, offering me valuable advice and inspiration throughout the entire project. I am deeply grateful for his patience and constant support.

A note of gratitude also goes to the members of the doctoral committee, who rigorously evaluated this work and provided valuable suggestions for its improvement. Their constructive criticism and guidance have contributed to the clarification and deepening of the aspects discussed in this thesis.

Lastly, I want to express my gratitude to my family for their unconditional support and constant encouragement during these years of study. Without their love and understanding, the realization of this work would not have been possible. I also thank my friends and loved ones for their emotional support and for the moments of relaxation that made this journey more enjoyable and bearable.

This doctoral thesis constitutes an original intellectual creation, over which I hold all intellectual property rights. Any use of the content of this work, in the absence of my prior consent, is strictly prohibited. The content of the doctoral thesis is protected by copyright in accordance with national and international law.

In conclusion, this doctoral thesis aims to offer innovative solutions for improving the quality of complex structural designs, thus contributing to scientific and technological progress in the field of aeronautical engineering. I hope that the results obtained will inspire new research directions and support the development of advanced technologies that ensure high standards of safety and efficiency in aviation.

Eng. Eliza-Ioana ALBU (Căs. APOSTOL)

INTRODUCTION

This doctoral thesis focuses on investigating and analyzing how advanced technical systems can contribute to improving the quality of complex structural designs in the aviation field. By exploring modern technologies and innovative methods, the primary goal of this doctoral thesis is to make significant contributions to enhancing the quality and performance of structures used in aviation. The thesis is structured into several chapters, each contributing to a deeper understanding and the development of innovative solutions. Chapter 1 provides an analysis of the evolution of aviation, highlighting the contributions of Romanian pioneers Traian Vuia, Aurel Vlaicu, and Henri Coandă, and the impact of their innovations on the development of aviation. This chapter lays the historical foundation for the subsequent research on the quality of complex aeronautical structures. Chapter 2 focuses on quality assurance and management, offering a detailed analysis of relevant theories and models. The foundations, theories, and models of quality assurance, as well as current trends and research directions in the aviation field, are explored. Chapter 3 investigates the improvement of the quality of scientific research in the aeronautical field, analyzing the practices and methods used to evaluate and optimize research quality. Chapter 4 addresses risk management and security in applied research within aeronautics. It analyzes theories, models, and practices of risk and security management, highlighting challenges and opportunities for improving these aspects.
Chapter 5 analyzes the use of advanced technical systems in research organizations to improve the quality of complex structural designs. The integration and efficiency of these technologies in research and development processes are investigated. Chapter 6 synthesizes the current state of knowledge in ensuring and improving the quality of complex structures, emphasizing the importance of strict standards and advanced technologies for achieving safe and reliable structures. Gaps in current knowledge are identified, and future research directions are proposed. Chapter 7 establishes the research directions, main and specific objectives of the thesis, and elaborates a rigorous methodology for ensuring and improving the quality of complex structures, providing a clear direction for future research. Chapter 8 details the innovative contributions made through the combined use of mathematical and experimental methods to improve the aerodynamic performance of complex structures. Mathematical models validated through experimental tests are presented, demonstrating the efficiency of the proposed solutions. Chapter 9 explores the application of the "Six Sigma" methodology for improving the quality of complex structural designs. The implementation of the DMAIC (Define, Measure, Analyze, Improve, Control) methodology allows for the identification and elimination of variations and defects in testing processes, contributing to the optimization of structural performance. Chapter 10 addresses the application of the FMEA (Failure Modes and Effects Analysis) method for optimizing and improving the quality of processes in the aeronautical industry. The implementation of FMEA allows for the proactive identification of potential failures and the evaluation of their impact on the overall performance of complex structures, contributing to the reduction of risks and improvement of the reliability of testing processes. Chapter 11 presents the final conclusions, original contributions, and future research directions. The main findings and results obtained are synthesized, emphasizing the impact of using advanced technical systems in improving the quality and performance of complex structures and proposing the extension of the applicability of the developed methodologies to other types of structures and industrial fields.

PART I - THE CURRENT STATE OF KNOWLEDGE IN QUALITY ASSURANCE AND IMPROVEMENT OF COMPLEX STRUCTURAL DESIGNS USING ADVANCED TECHNICAL SYSTEMS

1 THEORETICAL CONSIDERATIONS REGARDING THE PRESENTATION OF CHRONOLOGICAL MILESTONES IN CIVIL AND MILITARY AVIATION

Chapter 1 of this doctoral thesis explores the evolution of civil and military aviation, highlighting key chronological milestones and achievements that have significantly influenced these fields. The chapter begins with an analysis of the evolution of civil aviation, emphasizing the first powered flights and innovations in aircraft construction. Early achievements that paved the way for the development of efficient and safe air transport are highlighted. Technological innovations and continuous developments have contributed to the improvement of air transport safety and efficiency. The chapter continues with the evolution of military aviation, emphasizing the first uses of aeronautics for military purposes and the development of aeronautical units.

The chapter provides a necessary historical perspective for understanding the context and importance of technological innovations in aviation. The analysis of chronological milestones allows for the identification of major trends and challenges, laying the foundation for subsequent research on quality and quality assurance in the aerospace field. This theoretical foundation is essential for exploring modern methods of improving the performance and safety of complex structural profiles.

2 THEORETICAL CONSIDERATIONS REGARDING THE CURRENT STATE OF KNOWLEDGE IN THE FIELD OF QUALITY ASSURANCE AND MANAGEMENT IN THE CONTEXT OF THE DOCTORAL RESEARCH TOPIC

Chapter 2 of the doctoral thesis explores the fundamental theoretical aspects of quality and quality assurance, with a particular focus on the context of the aeronautical industry. Quality is analyzed through the lens of various associated concepts, including "Total Quality" and the "Zero Defects Strategy." These concepts are essential pillars in quality assurance and process management, offering significant benefits for improving efficiency, safety, and quality in research and development processes within the aeronautical field. The implementation of these concepts contributes to achieving an exceptional standard of quality and safety in the development of aircraft, equipment, and technologies.

The chapter details the concept and application of quality management, highlighting the importance of international standards such as ISO 9001 and AS9100. These standards provide a common and universally accepted framework, facilitating collaboration and information exchange between organizations. Quality management involves planning, organizing, coordinating, monitoring, and controlling activities to achieve established quality objectives. Responsibility for quality management is distributed across all management levels, with top management bearing the primary responsibility for coordination.

The chapter also explores the relationship between quality assurance and management and the organization as a system, including research organizations, learning organizations, and knowledge-based organizations. These types of organizations play a crucial role in the context of a knowledge-based economy, where quality and knowledge management become interdependent and essential for long-term success. Additionally, the chapter emphasizes the importance of technical quality control within the quality assurance process in the aeronautical field. The rigorous evaluation of every aspect of aircraft production, maintenance, and operation contributes to maintaining high-quality standards and delivering products and services that meet industry requirements. Technical quality control is fundamental to ensuring the integrity and safety of aircraft.

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3 CURRENT STATE OF KNOWLEDGE REGARDING THE IMPROVEMENT OF SCIENTIFIC RESEARCH QUALITY IN THE AERONAUTICAL FIELD WITH DIRECT REFERENCE TO THE DOCTORAL RESEARCH TOPIC

Building on the theoretical foundations presented in Chapter 2, where essential concepts and the relevant theoretical framework for improving quality and performance in the aeronautical field were explored, Chapter 3 continues this analysis by focusing on the current state of knowledge in the domain. This chapter is necessary to contextualize and validate the applicability of theory in practice, providing a solid basis for the modern methodologies and approaches used in aeronautical research. The continuity between these two chapters is crucial to ensure a logical and well-founded transition from theory to practical applicability, thereby supporting the development of a comprehensive perspective on the research topic.

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This chapter explores the objectives and opportunities that can be implemented within the research, as illustrated in Figure 3.1, with the result of immediate positive effects on the environmentThese objectives and opportunities are designed to guide research in quality assurance and management within the aeronautical industry towards innovative and sustainable solutions, with an immediate and positive impact on the environment. Implementing these strategies not only brings ecological benefits but also strengthens the reputation of organizations regarding social responsibility and sustainability.

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In a context where social and environmental responsibility are becoming increasingly central, strategies and key indicators for reducing environmental impact and fuel consumption are essential pillars for the sustainable transformation of the aeronautical industry. This transition not only brings ecological benefits but also contributes to the sustainable consolidation of the industry, addressing the needs of the present while also meeting the demands of future generations. (See Figure 3.3)

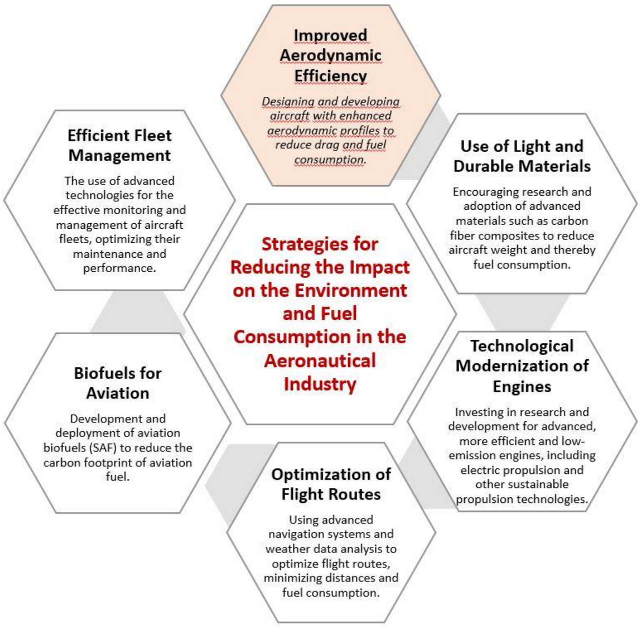

Fig. 3.1 Strategies for Reducing Environmental Impact and Fuel Consumption in the Aeronautical Industry

In the face of global challenges related to climate change and the need for sustainable development, improved aerodynamic efficiency in the aeronautical industry is becoming a crucial pillar for achieving sustainability goals and reducing environmental impact. This chapter explores and highlights the significant benefits brought by enhanced aerodynamic efficiency in the context of air transport. (Cook G., 2017)

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In conclusion, improved aerodynamic efficiency is a crucial pillar in strategies for reducing environmental impact and fuel consumption in the aeronautical industry. The implementation of innovative solutions and advanced technologies, as illustrated in Figure 3.5, in the design and operation of aircraft is essential for creating a more sustainable and energy-efficient aeronautical industry. Enhanced aerodynamic efficiency is a fundamental component in transforming the aeronautical industry into a more sustainable sector. This evolution not only meets society's expectations regarding environmental protection but also brings significant economic and technological advantages. Moving forward, the exploration and adoption of solutions that optimize aerodynamic performance remain key to positive progress toward greener and more efficient aviation. (Gaspar M., 2018)

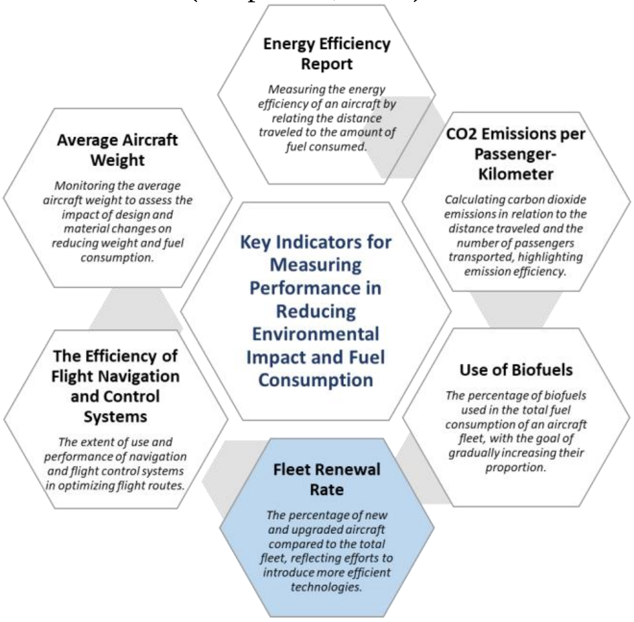

Fig. 3.2 Key Performance Indicators for Measuring Environmental Impact and Fuel Consumption Reduction

The fleet modernization rate, as shown in Figure 3.6, is a crucial indicator in the aeronautical industry's efforts to achieve sustainability goals and reduce environmental impact and fuel consumption. This indicator reflects the proportion of new or upgraded aircraft compared to the total fleet of a company or industry (O'Connell J., 2016). The adoption of advanced technologies is the primary objective of this doctoral thesis, and this aspect has been highlighted by presenting key indicators. The fleet modernization rate reflects the extent to which advanced technologies are being adopted in current practice. Modern aircraft are designed with improved aerodynamic features, more efficient engines, and innovative materials, all contributing to reduced fuel consumption and emissions.

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Chapter 3 emphasizes the importance of implementing rigorous standards and structured methodologies to improve the quality of scientific research in the aeronautical field, highlighting the crucial role of quality assurance in achieving precise and reliable results. The chapter also underscores the need for continuous adaptation to new technological challenges and the use of effective quality management and evaluation strategies, integrating international standards to standardize practices and facilitate collaboration between organizations.

4 CURRENT STATE OF KNOWLEDGE REGARDING THE CONCEPTUAL AND PRAGMATIC APPROACH TO RISK MANAGEMENT AND SECURITY IN APPLIED RESEARCH IN THE FIELD OF AERONAUTICS

Following the exploration of the current state of knowledge and methodologies used in aeronautical research presented in Chapter 3, Chapter 4 continues this endeavor by applying these insights concretely to risk management and security in applied research. This transition is essential to demonstrate how the theories and practices discussed earlier are implemented in practice, thereby ensuring a comprehensive and integrated approach to the research topic. The continuity between these two chapters emphasizes the importance of the close connection between theoretical knowledge and practical application, underpinning the effectiveness of the proposed approach in the doctoral thesis.

This chapter examines the current state of knowledge in risk management and security in the aeronautical field, highlighting both conceptual and pragmatic aspects. Conceptually, risk management involves a deep understanding of specific risks, such as human errors and technical failures, and the use of frameworks like the "Safety Management System" (SMS) and "Threat and Error Management" (TEM) to systematically manage risks. Pragmatically, the focus is on the implementation of practical measures and procedures, using advanced tools and technologies to reduce the likelihood and severity of unwanted events. The chapter's objectives include evaluating the performance of risk management and security systems and developing innovative solutions to improve the safety and efficiency of aeronautical operations.

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The concept of operational safety and the concept of security are two areas frequently discussed and applied in the aeronautical field, each with its own characteristics and implications, as we can observe in Table 4.1. (Brown M.,2019)

Tab. 4.1 The Concept of Operational Safety vs. The Concept of Security, Applied in the Aeronautical Field

Safety	Security
Operational safety is primarily concerned with the prevention of accidents and incidents within aeronautical operations.	Security in the aeronautical field is concerned with protection against intentional acts of interference or destruction, such as terrorism or aircraft hijacking.
This concept focuses on identifying and eliminating risks that could lead to unwanted events or compromise the operational safety of aircraft and associated systems.	This concept involves the implementation of measures and procedures aimed at preventing and countering threats to the security of air operations, including the protection of airport infrastructure, aircraft, and passengers.
The main methodologies used in ensuring operational safety include risk analysis, Failure Modes and Effects Analysis (FMEA), Fault Tree Analysis (FTA), and Process Hazard Analysis (PHA).	Security measures can include passenger and baggage screening, video surveillance, access controls, and other procedures aimed at reducing the risk of terrorist attacks or similar incidents.
The ultimate goal of operational safety is to minimize the likelihood of accidents and to protect lives and property.	In contrast to operational safety, which focuses on accident prevention, security aims at preventing and countering intentional acts of violence or sabotage.

The differences between these two concepts are essential in defining and implementing policies and procedures in the aeronautical field. While operational safety focuses on managing accidental and natural risks, security targets intentional threats and malicious actions. In practice, however, these two aspects are often integrated into a holistic approach to ensuring the integrity of air operations. (Kearns S. K., 2018)

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The current state of knowledge in risk management and security in applied research within the aeronautical field reflects significant advancements both theoretically and practically. In recent decades, there has been a deepened understanding of the complexity of risks and threats specific to this field, with conceptual frameworks such as the "Safety Management System" (SMS) and "Threat and Error Management" (TEM) providing a solid foundation for a proactive approach to operational risks. Simultaneously, applied research has contributed to the development and implementation of pragmatic solutions, including advanced technologies and monitoring systems, aimed at minimizing risks and ensuring a high level of security. The performance evaluation of these systems and technologies has been essential, carried out through empirical studies, computer simulations, and data analysis, which have provided valuable insights for the continuous improvement of risk management practices. Moreover, the emphasis on innovation and continuous development has been crucial, with collaboration between industry, academia, and regulatory authorities playing a key role in adapting to emerging risks and threats. In conclusion, progress in risk management and security in aeronautics is based on a synthesis of solid conceptualization, practical application, and continuous innovation, all contributing to the enhancement of safety and efficiency in aeronautical operations..

5 CURRENT STATE OF KNOWLEDGE IN THE FIELD OF THE DOCTORAL RESEARCH TOPIC REGARDING THE USE OF ADVANCED TECHNICAL SYSTEMS WITHIN A RESEARCH ORGANIZATION FOR THE STUDY OF IMPROVING THE QUALITY OF COMPLEX STRUCTURAL PROFILES

This chapter builds on the conclusions and perspectives developed in the previous chapter, highlighting how security requirements and risk management influence the evolution and dynamics of market segments. It examines the current state of knowledge regarding the use of advanced technical systems, such as wind tunnels, to improve the quality of complex structural profiles in the aeronautical and aerospace fields. Wind tunnels are essential for testing and evaluating vehicles under controlled conditions, contributing to the design and development of more efficient and safer models. The current state of research in this field is promising, indicating a clear direction towards innovation and continuous progress in aeronautical and aerospace engineering. (Abdus A., 2020)

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In conclusion, the current state of knowledge regarding the use of advanced technical systems for studying the improvement of the quality of complex structural profiles demonstrates significant progress in the application of modern technologies in research. However, there are still challenges and opportunities for innovation and continuous development in this field. The future research directions to be addressed in this doctoral thesis will focus on improving the efficiency and accuracy in the process of enhancing the quality of complex structural profiles.

6 CONCLUSIONS REGARDING THE CURRENT STATE OF KNOWLEDGE IN THE FIELD OF QUALITY ASSURANCE AND IMPROVEMENT OF COMPLEX STRUCTURAL PROFILES USING ADVANCED TECHNICAL SYSTEMS

The first part of the research aims to clarify the concept of quality in the aeronautical field. The choice of this doctoral topic is based on the significant importance of the quality management system in current products and services.

The analysis of literature and previous research reveals an increased interest in the use of advanced technical systems for the study and improvement of structural profiles in the aeronautical industry. There is a general recognition of the importance of developing innovative technologies and methods to optimize aircraft performance and safety.

Existing methods and technologies currently used in research organizations within the aeronautical field for studying and improving complex structural profiles have been identified and analyzed. These include advanced modeling and simulation techniques, computational structural analysis, the use of composite materials, and the development of structural integrity monitoring systems.

PART II - Contributions to Improving the Quality of Complex Profile Structures Using Advanced Technical Systems

7 DIRECTIONS, MAIN OBJECTIVE, SPECIFIC OBJECTIVES, AND RESEARCH METHODOLOGY FOR ENSURING AND IMPROVING THE QUALITY OF COMPLEX PROFILE STRUCTURES USING ADVANCED TECHNICAL SYSTEMS

This chapter is essential for defining the conceptual and methodological framework necessary to ensure and improve the quality of complex profile structures. In an era where the demands for superior aerodynamic performance and structural efficiency are constantly increasing, the use of advanced mathematical and experimental methods becomes fundamental. This chapter aims to describe the main research directions that will guide the investigations and development efforts within this doctoral thesis.

To improve aerodynamic performance and ensure structural quality, the research will focus on four main directions: aerodynamic characteristics analysis, mathematical modeling, experimental methods, and the application of quality improvement methods. These directions are further detailed to provide a clear understanding of the scientific and technical approach, as illustrated in Figure 7.1.

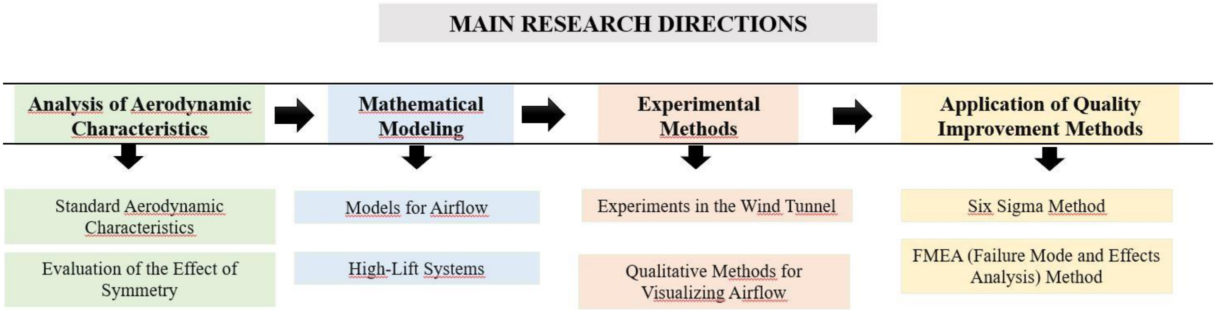

Fig. 7.1 Main Research Directions

By addressing these research directions, the doctoral thesis aims to make a significant contribution to improving the aerodynamic performance of complex structural designs, while also ensuring their quality and efficiency.

7.1 Main objective and specific objectives proposed in the doctoral research

Specific Objectives:

- Develop advanced mathematical models for simulating aerodynamic flow around complex profile structures.
- Identify critical points and optimization opportunities in aerodynamic design.
- Conduct precise wind tunnel experiments to validate mathematical and theoretical models.
- Collect and analyze empirical data to adjust and improve the design of structures.
- Propose and test design modifications to reduce aerodynamic drag.
- Evaluate the impact of these modifications on lift and overall performance of the structures.
- Apply the DMAIC (Define, Measure, Analyze, Improve, Control) approach to identify and eliminate variations and defects in testing processes.
- Design and implement solutions for continuous quality optimization and control.
- Proactively identify potential failure modes in aerodynamic testing processes.
- Evaluate impact and prioritize risks by calculating the Risk Priority Number (RPN).
- Develop and implement corrective and preventive measures to minimize identified risks.

- Document the methodology, results, and lessons learned from the application of testing and optimization methods.
- Publish and present the research results to the scientific and industrial community to encourage the adoption of best practices and innovations in the field.

By achieving these specific objectives, the doctoral research will make significant contributions to improving the quality, aerodynamic performance, and durability of complex profile structures. The integrated approach, combining mathematical modeling, experimental validation, Six Sigma methodology, and FMEA analysis, will demonstrate the effectiveness and applicability of the proposed solutions, thus advancing knowledge and practices in aeronautical and structural engineering. These accomplishments open new avenues for future research and industrial implementations, ensuring continuous progress in the development of efficient, safe, and durable aerodynamic structures.

7.2 Proposed research methodology in the doctoral research

The proposed research methodology involves an integrated and systematic approach, combining advanced mathematical methods, rigorous experimental testing, and quality management techniques to improve complex profile structures. This includes a literature review for theoretical grounding, the design and execution of wind tunnel experiments, and the development and validation of mathematical models for simulating aerodynamic behavior. Additionally, the methodology applies the DMAIC approach of the Six Sigma method for process optimization and control, and uses FMEA analysis to identify and minimize potential risks. Through this combination of methods, the research aims to ensure the quality, performance, and durability of aerodynamic structures.

The proposed research methodology is designed to systematically and rigorously address the research objectives by integrating mathematical methods, experimental testing, and quality management techniques. In the first stage, a detailed literature review will be conducted to establish the theoretical foundation and identify existing gaps. The next stage involves the experimental phase, where the technical specifications and procedures necessary for testing the structures in wind tunnels will be defined.

8 CONTRIBUTIONS TO IMPROVING THE AERODYNAMIC PERFORMANCE OF COMPLEX PROFILE STRUCTURES USING CERTAIN MATHEMATICAL AND EXPERIMENTAL METHODS

8.1 Contributions to the analysis of specific characteristics of standard aerodynamic profiles using the wind tunnel

This subchapter focuses on the analysis of the aerodynamic characteristics of standard profiles using the wind tunnel. The study begins with the presentation of a standard aerodynamic profile and the investigation of its specific characteristics, with an emphasis on its symmetry. During the experiments, aerodynamic coefficients such as the lift coefficient and drag coefficient were measured for different angles of incidence. The results highlighted the sensitivity of these coefficients to variations in the Reynolds number. The analyses led to important conclusions regarding the aerodynamic performance of the profile, emphasizing the need for improvements to optimize it for aeronautical applications.

8.2 Contributions to the analysis of the aerodynamic performance of a selected symmetric profile

This subchapter explores the aerodynamic performance of a specific symmetric airfoil profile, considered relevant for modern applications such as UAVs and MAVs. The study analyzed the effect of the Reynolds number on the aerodynamic behavior of the profile, noting that at low Reynolds numbers, the boundary layer tends to separate prematurely, thereby reducing lift and increasing drag. The experiments confirmed the importance of these factors in optimizing the aerodynamic performance of the profile, providing essential data for improving its design.

8.3 Contributions to the mathematical modeling of airflow around the selected standard (symmetric) aerodynamic profile

Chapter 8.3 focuses on the mathematical modeling of airflow around a symmetric aerodynamic profile, adapted with a high-lift system. Mathematical modeling was approached as an essential method for predicting the aerodynamic behavior of the selected profile, thus allowing for a detailed analysis of the effects of the high-lift system and variability depending on angles of attack. The necessity of this research is underscored by the increasing performance demands in the aeronautical industry, where predictive modeling helps identify the most efficient design solutions.

Figures 8.31, 8.32, and 8.33 illustrate the velocity and pressure contours around the aerodynamic profile at different angles of attack, highlighting how these variables are influenced by adjustments to the high-lift system.

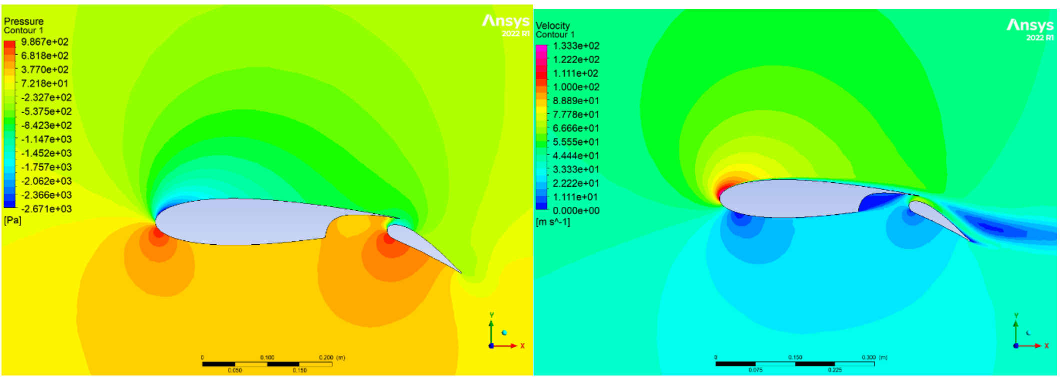

Fig. 8.1 The velocity and pressure contours for the NACA 0018 profile with high-lift system at a 0-degree angle of incidence

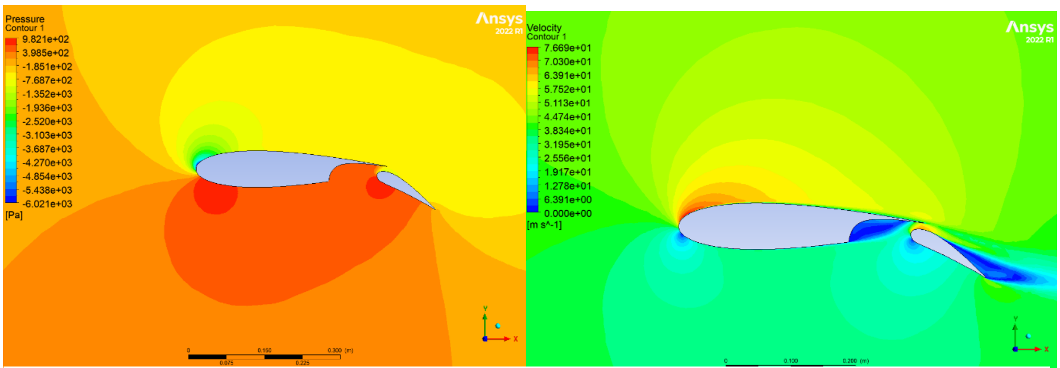

Fig. 8.22 The velocity and pressure contours for the NACA 0018 profile with high-lift system at a 10-degree angle of incidence

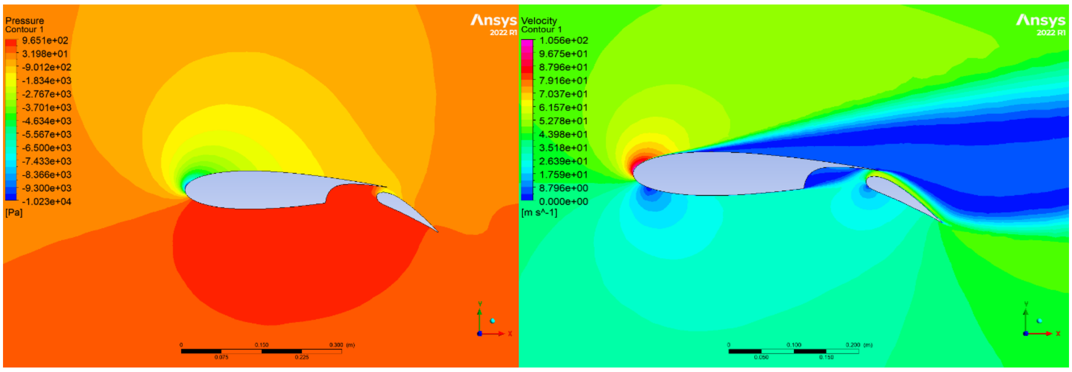

Fig. 8.33 The velocity and pressure contours for the NACA 0018 profile with high-lift system at a 15-degree angle of incidence

Overall, the chapter highlights the importance of integrating mathematical modeling into the processes of aerodynamic development and optimization, emphasizing its critical role in achieving superior performance and improving the efficiency of aeronautical systems. The proposed model, validated through the presented experiments, demonstrates the effectiveness of the developed solutions and significantly contributes to the advancement of knowledge in the field of aerodynamic engineering.

8.4 Contributions to the use of qualitative methods for visualizing airflow using models

Chapter 8.4 of the doctoral thesis addresses the contributions made in the use of qualitative methods for visualizing airflow using aerodynamic models. These methods are essential for visually and intuitively understanding the behavior of airflow around models, allowing researchers to identify complex aerodynamic phenomena that may be difficult to observe and analyze using only quantitative methods.

The chapter describes the application of these methods in detail, highlighting their importance in validating numerical models and identifying areas with aerodynamic issues. It also discusses aspects related to minimizing risks associated with the use of these methods, emphasizing the need for rigorous personnel training and the implementation of strict safety protocols. The chapter dedicated to the holistic qualitative methodology for risk minimization presents a complex and integrated approach, essential for ensuring the reliability and validity of research in aerodynamics.

The methodology begins with the identification of risks associated with each step of the experimental process. This stage involves a detailed analysis of potential sources of errors, including measurement errors, subjective interpretation of visual data, or unexpected variations in experimental conditions. Risk identification is followed by evaluation and management, where each risk is analyzed based on its potential impact on the results and the likelihood of occurrence. In this phase, specific strategies are developed to minimize or eliminate the identified risks. This approach is crucial for preventing unwanted events that could compromise the integrity and safety of the experiments while ensuring that the results obtained are robust and relevant for practical application in the aeronautical industry.

In conclusion, the chapter emphasizes that qualitative methods for visualizing airflow are indispensable tools in aerodynamic research, providing valuable insights that can contribute to the development of efficient and innovative aerodynamic solutions. These methods complement the data obtained from numerical simulations, ensuring rigorous validation and a deeper understanding of the phenomena studied.

8.5 Conclusion

The conclusion emphasize the importance of the methods used for analyzing and optimizing the aerodynamic performance of complex profile structures. The study demonstrated the effectiveness of using mathematical modeling and qualitative methods for visualizing airflow, as well as the relevance of adapting these methods to meet the current needs of the aeronautical industry. Additionally, the importance of integrating a holistic risk minimization methodology in research and development processes was highlighted, thereby ensuring a high level of safety and reliability of the results.

The chapter concludes that the approaches used allowed for a deep and detailed understanding of complex aerodynamic phenomena and contributed to the advancement of knowledge in the field of aeronautical engineering. The results obtained not only validate the proposed methods but also provide a solid foundation for future research and practical applications in the development of advanced aerodynamic technologies.

These conclusions reinforce the original contributions of the thesis, demonstrating the significant impact of the research in optimizing aerodynamic performance and improving design and testing processes in the aeronautical field..

9 CONTRIBUTIONS TO THE APPLICATION OF THE "SIX SIGMA" METHOD FOR IMPROVING THE QUALITY OF COMPLEX PROFILE STRUCTURES USED IN THE DOCTORAL RESEARCH

This chapter investigates the application of the Six Sigma methodology in aeronautical research, focusing on the implementation of the DMAIC (Define, Measure, Analyze, Improve, Control) approach to optimize the development processes of complex structural designs. Six Sigma, recognized for improving quality and reducing variations in industrial processes, is used to ensure excellence and reliability in aerodynamic structures. The chapter presents the theoretical foundation of the method in this context, followed by practical case studies that demonstrate its implementation. The emphasis is on the analysis of experimental data and the identification of deficiencies in the performance of the structures, which are then addressed and corrected using specific Six Sigma tools.

This chapter aims to demonstrate how the application of the Six Sigma methodology can significantly contribute to improving the quality and efficiency of complex aerodynamic structures, providing a systematic and rigorous framework for addressing challenges in aeronautical research. Through this methodology, the doctoral research can achieve a higher level of precision and reliability in technical aeronautical development.

9.1 Application of the Six Sigma method in aeronautical research: concepts, implementation, and the DMAIC approach

Chapter 9.1 of the doctoral thesis examines the application of the Six Sigma method in aeronautical research, highlighting the crucial role of this method in improving the quality and efficiency of complex aerodynamic structures. Six Sigma, recognized for its ability to reduce variations and eliminate defects in industrial processes, is adapted to optimize aeronautical research and development processes. The chapter details the implementation of the DMAIC (Define, Measure, Analyze, Improve, Control) cycle, emphasizing the importance of each stage, from defining objectives and measuring performance to analyzing, implementing improvement solutions, and continuous process control.

The chapter also presents case studies illustrating how the Six Sigma method was applied in applied research within subsonic wind tunnels, highlighting the positive impact on the quality and relevance of experimental results. These concrete examples demonstrate that the rigorous application of the methodology can lead to significant improvements in testing and development processes in aeronautics, thus contributing to the advancement of aerodynamic technologies. In conclusion, Chapter 9.1 argues that integrating the Six Sigma method into aeronautical research not only enhances the quality and efficiency of processes and products but also strengthens competitiveness in the aeronautical industry, ensuring compliance with the highest performance standards.

9.2 Exploring applied research in subsonic wind tunnels: implications for aeronautical technical development and integration of the Six Sigma method

In aeronautical research, optimizing the testing process in wind tunnels is a crucial aspect for improving the efficiency and accuracy of the aerodynamic parameters obtained. In this context, the DMAIC (Define, Measure, Analyze, Improve, Control) approach provides a robust methodological framework for identifying and solving problems encountered during the testing process.

Through this chapter, the aim of this doctoral thesis is to investigate and apply the DMAIC approach to improve the efficiency of processes within aeronautical research projects, with a focus on optimizing the aerodynamic parameters resulting from wind tunnel testing.

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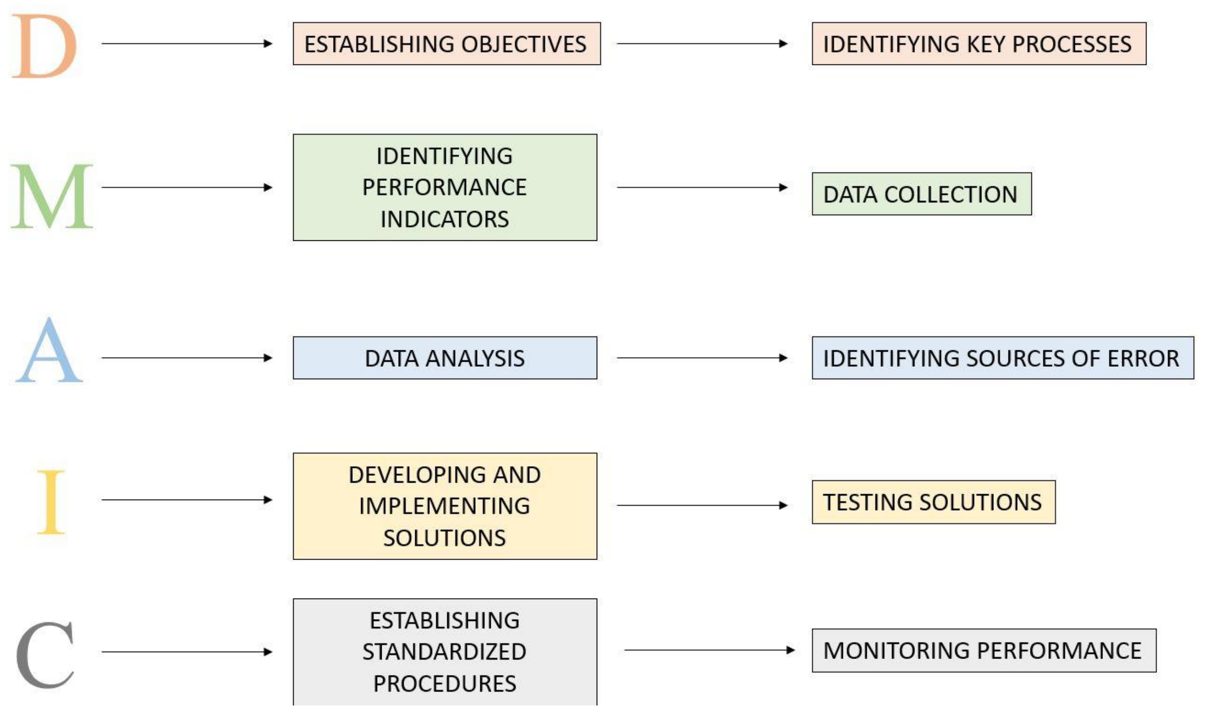

Fig. 9.1 The methodology for applying the DMAIC method

Applied research is a crucial component in the evolution of the aeronautical industry, providing practical and innovative solutions for improving the performance, safety, and efficiency of aircraft. This chapter explores the role and impact of applied research in aeronautical technical development, highlighting its significant benefits and contributions. The Six Sigma method represents a structured and data-driven approach to process and outcome improvement across various fields, including applied research in subsonic wind tunnels. Implementing the Six Sigma method in these research activities can enhance the efficiency, consistency, and relevance of experimental results. The methodology for applying the Six Sigma method, as discussed in this doctoral thesis, is presented in Figure 9.3.

9.3 Analysis and Improvement of Complex Profile Structure Performance in Subsonic Wind Tunnels: A Case Study in the Implementation of the Six Sigma Method

Chapter 9.3 of the doctoral thesis focuses on the analysis and improvement of the performance of complex profile structures used in subsonic wind tunnels, using the DMAIC methodology, a key tool within Six Sigma.

The chapter begins with the establishment of research objectives, which include reducing experimental errors and optimizing testing processes. In this Define phase, the critical parameters that influence the aerodynamic and structural performance of these structures were identified. Then, in the Measure phase, performance indicators were established, and data was collected to evaluate the processes and experimental results.

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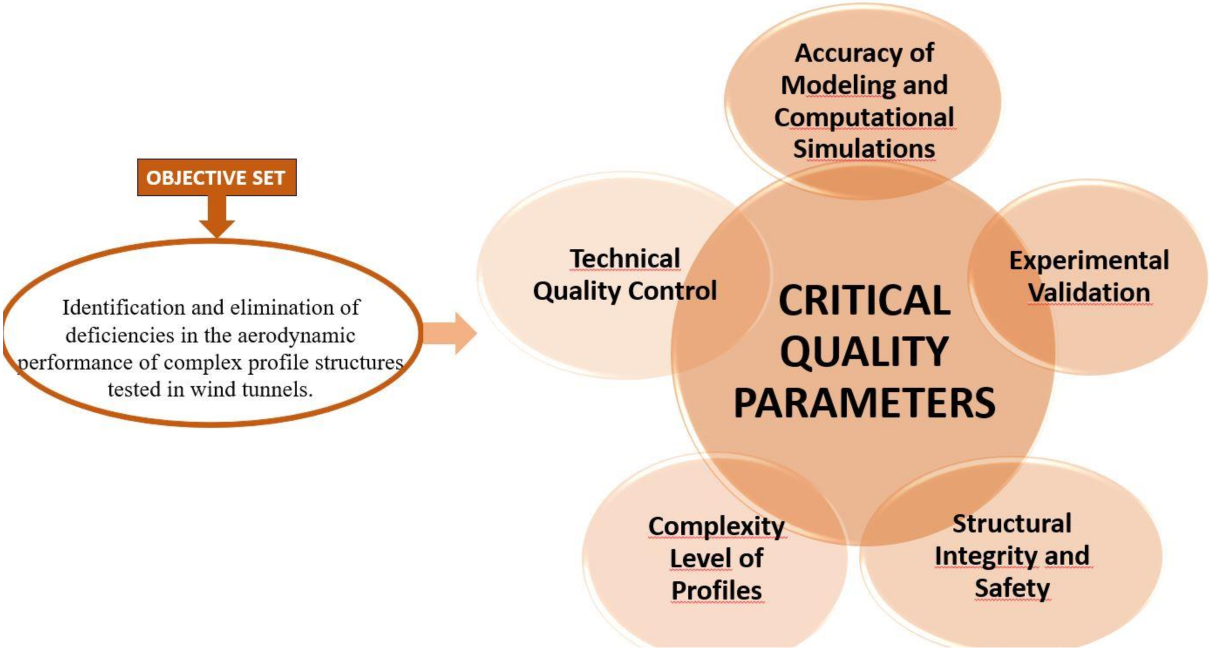

Fig. 9.2 The Define Phase of the Six Sigma Method in the Context of the Research Topic

The analysis involved the use of statistical and analytical techniques to identify potential sources of errors and variations. The Ishikawa diagram, Figure 9.16, was used to categorize and organize the potential causes of these deficiencies, including factors such as profile design, testing conditions, surface quality of the wing, and airflow conditions in the wind tunnel. This diagram provided a clear visualization of the root causes, facilitating their identification and resolution.

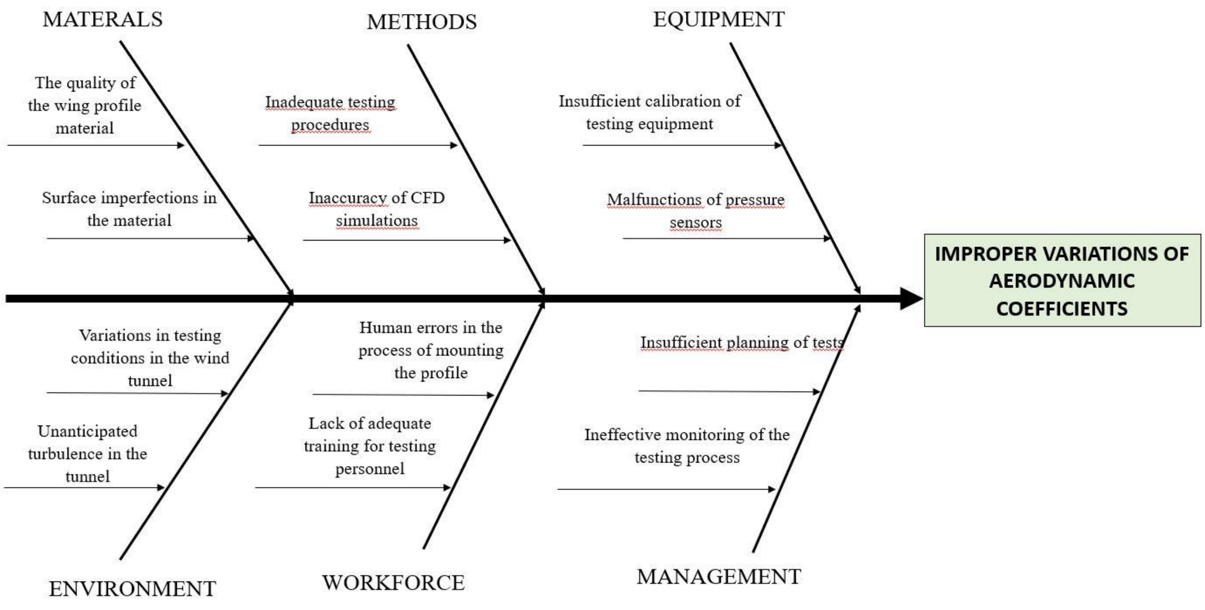

Fig. 9.3 Ishikawa Diagram for Root Cause Identification

By using the Ishikawa diagram, we were able to identify and address the root causes of deficiencies, thereby improving the performance of the wing profile and reducing the variability of aerodynamic coefficients.

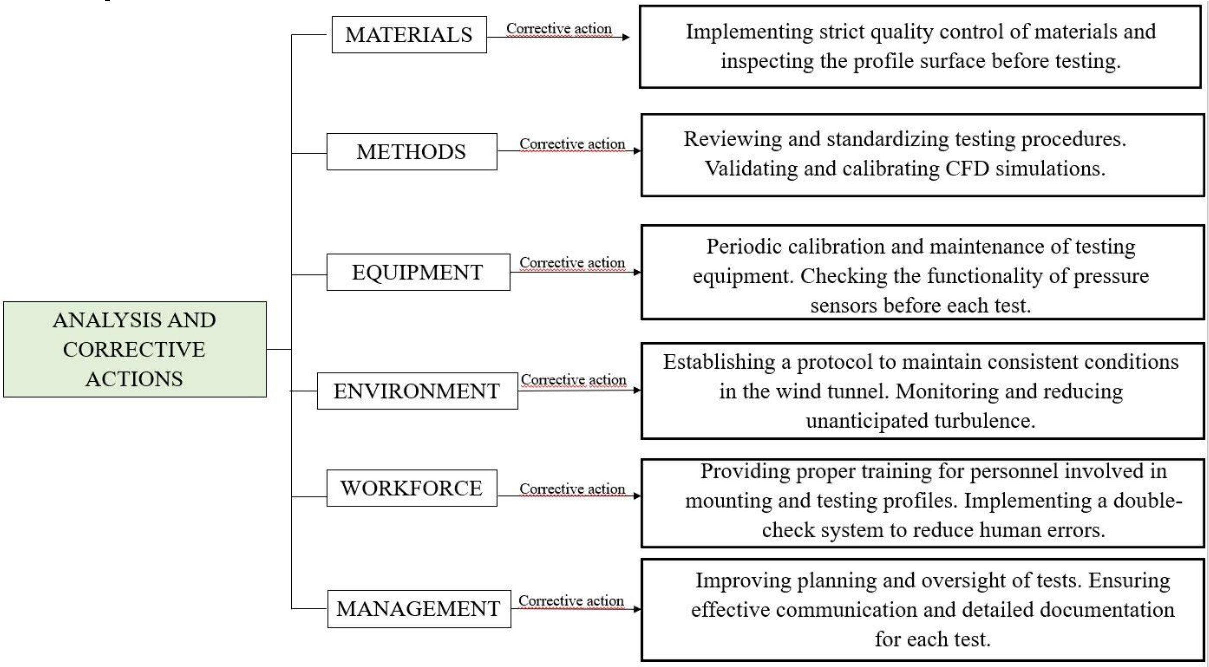

Fig. 9.4 Analysis and corrective actions

The Pareto chart was applied to analyze the frequency of deficiency causes, following the 80/20 principle. It was found that the most frequent deficiencies were related to the surface quality of the wing profile, followed by inadequate testing procedures and variations in airflow conditions, with these three categories accounting for 51.67% of the total identified deficiencies.

The next phase, Improvement, involved developing and implementing solutions to reduce variability and experimental errors, followed by testing these solutions to assess their impact on the quality of results. Finally, in the Control phase, standardized procedures and a continuous monitoring system were established to ensure the consistency and reliability of experimental results. These efforts led to a significant improvement in the quality and efficiency of aerodynamic experiments in subsonic wind tunnels, thereby contributing to overall progress in the aeronautical field.

9.4 Analysis of the Impact of Implementing the Six Sigma Method and Interpretation of the Results Obtained

This chapter focuses on evaluating the impact of implementing the Six Sigma method in applied research conducted in subsonic wind tunnels. The primary goal of this analysis is to determine the effects on the quality and efficiency of the aerodynamic structures tested. The implementation of the Six Sigma method in applied research conducted in subsonic wind tunnels was analyzed and assessed to determine its impact on the quality and efficiency of the aerodynamic structures tested.

The impact of the Six Sigma method implementation was evaluated by following the steps outlined in Figure 9.21:

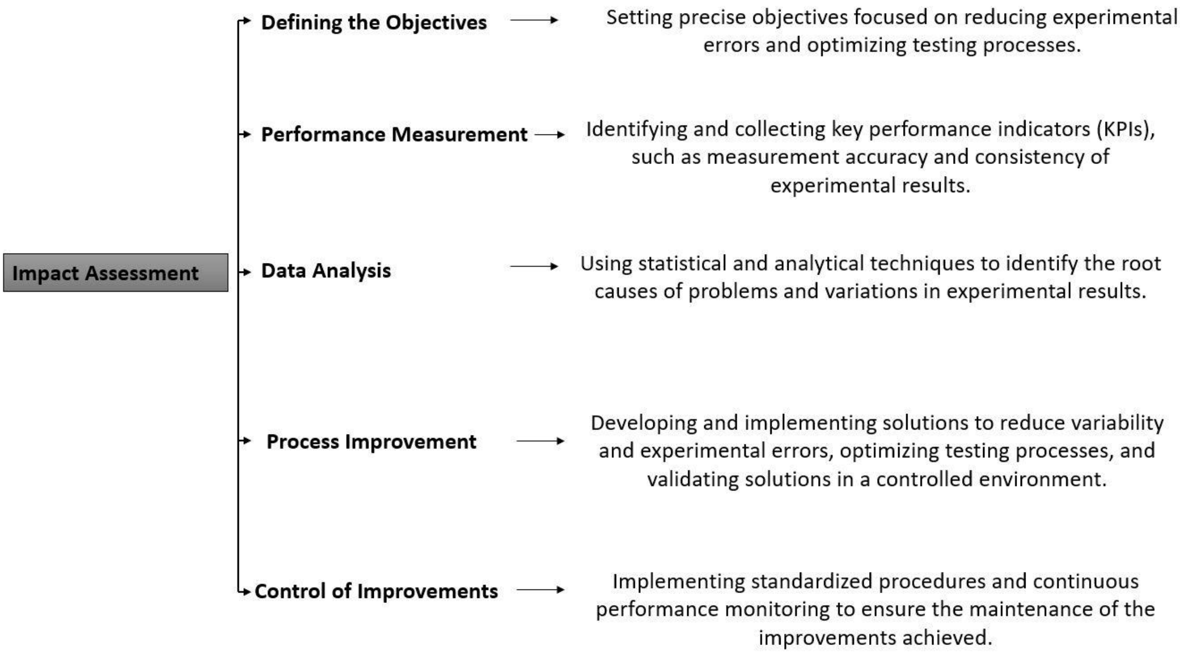

Fig. 9.5 The impact of implementing the Six Sigma method

This chapter focuses on evaluating the impact of implementing the Six Sigma method in applied research conducted in subsonic wind tunnels. Specifically, the analysis is centered on determining the effects of this methodology on the quality and efficiency of the aerodynamic structures tested.

The Six Sigma method, known for its rigorous and data-driven approach, was applied to optimize experimental processes and improve the results obtained. The impact assessment involved key stages such as defining objectives, measuring performance, analyzing data, improving processes, and controlling improvements.

The results of the method's implementation showed significant improvements in measurement accuracy, reduction of variability, and optimization of aerodynamic testing processes. A detailed analysis demonstrated the efficiency of the Six Sigma methodology in eliminating the root causes of variability and errors, thereby contributing to technological advancement in the aeronautical field.

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This chapter also presents the results obtained from the implementation of the Six Sigma method and the improvements made in aeronautical research processes. According to this chapter, the application of the methodology led to a significant reduction in measurement variability and an increase in the consistency of experimental data. These improvements were essential for the validity of experimental results, allowing for a more accurate interpretation of the aerodynamic behavior of the tested structures. Additionally, the chapter highlights the efficiency of the Six Sigma method in improving the quality and reliability of data, contributing to process optimization and increased operational efficiency in aerodynamic research.

10 CONTRIBUTIONS TO THE APPLICATION OF THE FMEA METHOD FOR IMPROVING THE QUALITY OF RELATED PROCESSES INTEGRATED INTO THE DOCTORAL RESEARCH

10.1 Introduction to the application of the FMEA method for optimizing performance and process reliability in the aeronautical industry

This chapter emphasizes the importance of improving the quality and reliability of processes in aeronautical research, highlighting the crucial role of the FMEA (Failure Modes and Effects Analysis) method. FMEA was applied in the doctoral research to identify and eliminate deficiencies in aerodynamic testing processes, leading to enhanced quality, increased reliability, process optimization, and cost reduction. The FMEA method has proven to be an essential tool for technological advancement and ensuring excellence in aeronautical research.

The main goal of this study is to implement and evaluate the effectiveness of the FMEA method in both fundamental and applied research within the aeronautical field. By using this method, the study aims to identify and eliminate potential deficiencies in aerodynamic testing processes, thereby improving the quality and reliability of experimental results. The ultimate objective of applying the FMEA method is to optimize the performance and reliability of aeronautical processes, contributing to technological development and continuous innovation in this domain.

Research on the application of FMEA in aeronautical processes is particularly relevant due to the stringent safety, performance, and reliability requirements in this industry. The aeronautical industry constantly faces challenges related to preventing deficiencies and ensuring high-quality products and processes. Therefore, FMEA provides a systematic framework for identifying and managing risks associated with these deficiencies.

The doctoral research on the application of the FMEA method makes significant contributions to the aeronautical field, both theoretically and practically, as presented in Figure 10.1:

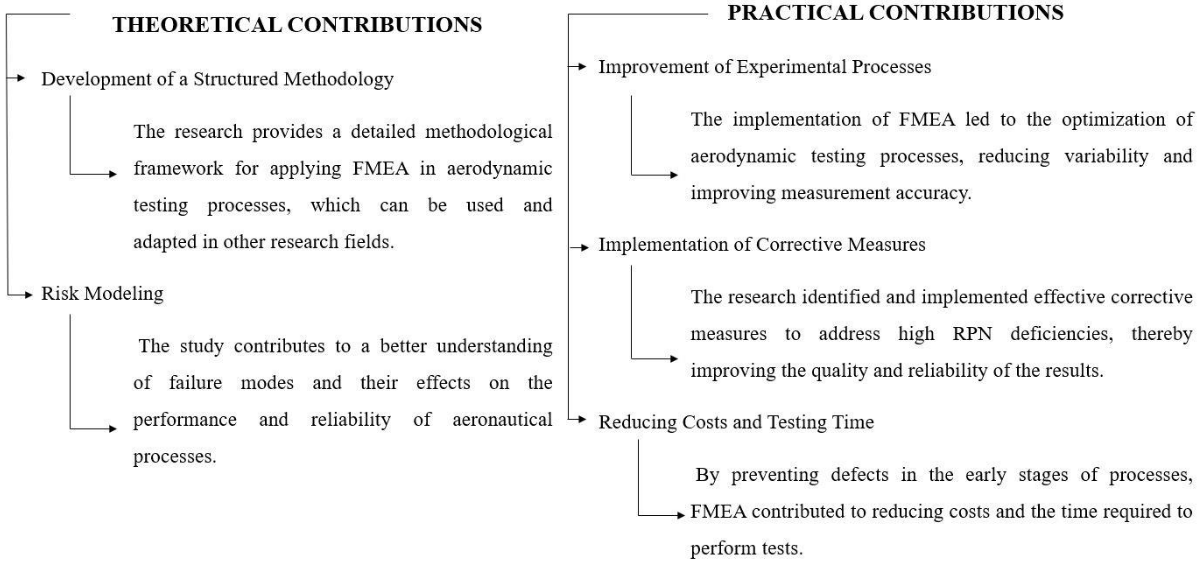

Fig. 10.1 Original contributions on the implementation of the SixSigma method

The relevance and contribution of the research on the application of the FMEA method in aeronautical processes are evident through the benefits brought in terms of safety, quality, and efficiency. This research demonstrates how the use of a rigorous deficiency analysis method can lead to significant improvements in the performance and reliability of processes, thereby supporting technological development and innovation in the aeronautical industry.

10.2 Theoretical foundation for the application of the FMEA method for optimizing process performance and reliability in the aeronautical industry

In the aeronautical industry, optimizing process performance and reliability is essential for ensuring safety and operational efficiency. Various methods and techniques are employed to identify, analyze, and improve critical processes. This section presents the theoretical foundations of applying the FMEA method, along with other complementary methods for optimizing process performance and reliability, as illustrated in Figure 10.2:

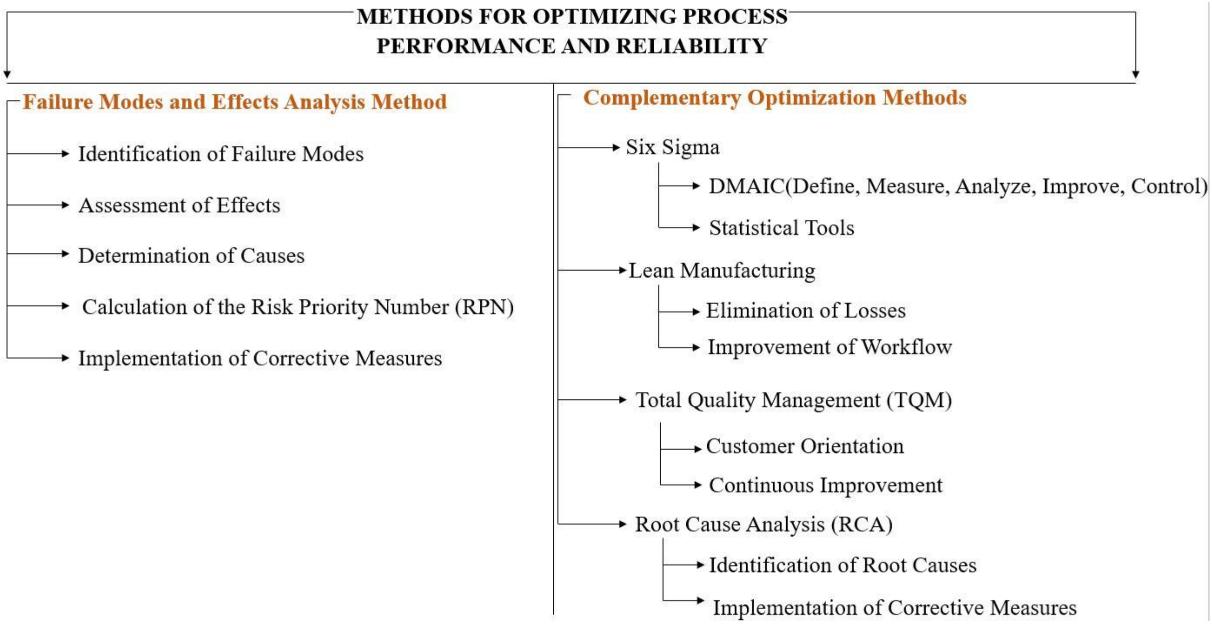

Fig. 10.2 Methods for optimizing process performance and reliability

Optimizing process performance and reliability in the aeronautical industry is essential for ensuring safety and operational efficiency. The FMEA method, along with other complementary methods such as Six Sigma, Lean Manufacturing, and TQM, provides a robust framework for identifying and managing risks associated with process deficiencies. The application of these methods contributes to continuous development and innovation in the aeronautical industry, thereby ensuring a high level of quality and reliability in products and processes.

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In the aeronautical industry, risk analysis is crucial for ensuring the safety, performance, and reliability of processes and products. Risk analysis involves identifying, assessing, and managing factors that could negatively impact the performance of a process or product. The FMEA (Failure Modes and Effects Analysis) method, as illustrated in Figure 10.3, is an effective and systematic tool used to identify and evaluate failure modes and their effects.

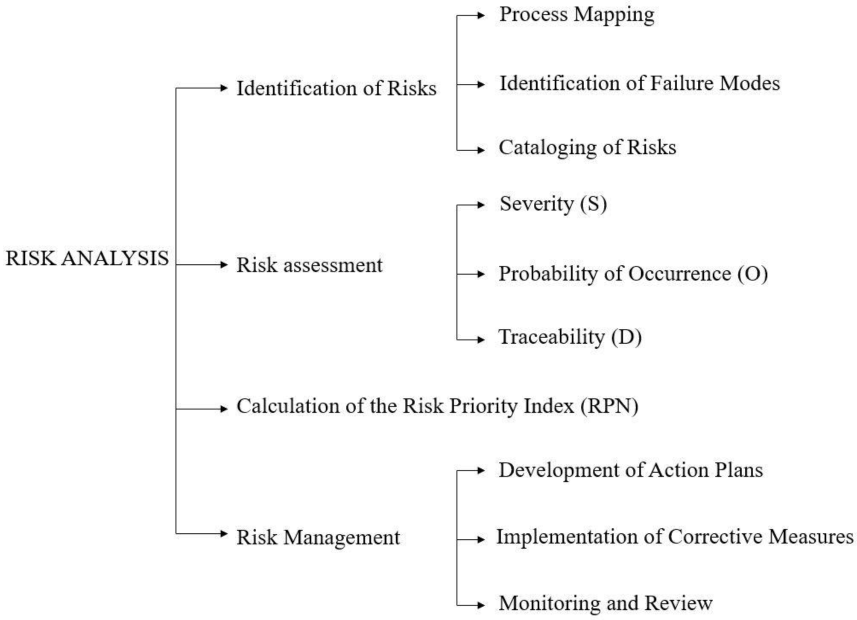

Fig. 10.3 Risk analysis

Risk analysis and the application of the FMEA method are essential for optimizing process performance and reliability in the aeronautical industry. By effectively identifying and managing risks, companies can ensure a high level of safety and quality, thus contributing to continuous development and innovation in this field. The FMEA method provides a robust framework for detailed deficiency analysis and the implementation of necessary corrective measures, thereby ensuring excellence in aeronautical processes.

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Integrating the FMEA method into experimental research in the aeronautical industry offers a systematic framework for identifying and managing risks associated with process and product deficiencies. This process contributes to improving the quality and reliability of results, optimizing testing, and enhancing safety and performance. FMEA allows for the early identification of risks, the implementation of corrective measures, and continuous process monitoring, thereby ensuring superior performance and supporting development and innovation in the aeronautical field.

10.3 Methodology and various approaches in using the FMEA method for improving process performance and reliability in the aeronautical industry

Planificarea Research planning is a critical step in using the FMEA (Failure Modes and Effects Analysis) method to improve process performance and reliability in the aeronautical industry. This phase involves clearly defining objectives, establishing the working team, identifying the necessary resources, and developing a detailed action plan.

In the previous chapter, the application of the Six Sigma methodology was discussed, focusing on reducing variability and improving quality in aeronautical processes through the systematic DMAIC (Define, Measure, Analyze, Improve, Control) approach. This methodology enabled the identification and elimination of critical variations in processes, ensuring greater consistency and accuracy in experimental results.

The study presented in this chapter continues the logic of Six Sigma implementation, using the FMEA method as an additional and complementary step to deepen risk analysis. While Six Sigma focused on reducing variability through process optimization, FMEA is applied to proactively identify and manage potential failure modes that could affect the reliability of aerodynamic pressure sensors.

Research planning remains a critical stage in applying the FMEA method, involving clear objective setting, team formation, resource identification, and the development of a detailed action plan.

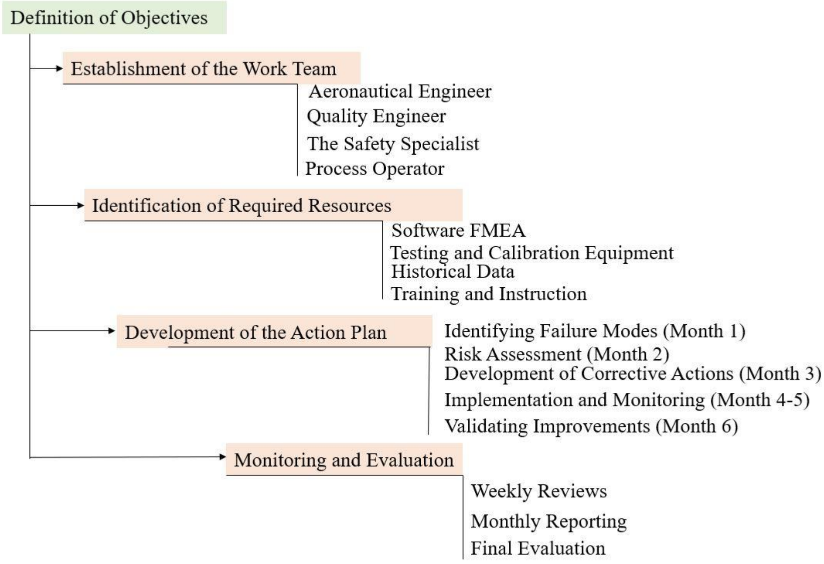

Fig. 10.4 Definirea obiectivelor pentru procesul de integrare al metodei FMEA în cercetările experimentale

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Detailed research planning is essential for the effective use of the FMEA method in improving process performance and reliability in the aeronautical industry. The concrete example presented demonstrates how a structured and systematic approach can lead to significant improvements in measurement variability and the overall quality of experimental processes.

In the aerodynamic testing process, defining the processes and identifying risks are crucial for ensuring the quality and reliability of measurements. The testing process is divided into distinct stages: wind tunnel preparation, sensor installation, test execution, data analysis, and periodic maintenance/calibration. Each stage is evaluated to identify potential failure modes, their causes, and effects. Risks may include testing equipment failure, improper sensor installation, unstable testing conditions, incorrect data interpretation, and lack of periodic calibration. Identifying these risks enables the development of corrective measures to reduce variability and improve the performance of aeronautical processes.

Furthermore, quality management has been integrated into experimental research to enhance the performance and reliability of aeronautical processes. This subchapter focuses on the systematic application of quality management principles within aerodynamic experiments, ensuring that each stage of the testing and development process is carried out according to the highest standards. Through this integration, we have optimized processes, monitored improvements, and ensured the consistency and reliability of the results obtained. This effort was crucial for achieving the established objectives and reinforcing the impact of the research in the aeronautical field.

Additionally, we addressed the techniques and tools used in risk analysis and quality management. This subchapter provides a detailed perspective on the various methods and technologies applied to effectively identify and manage risks in aeronautical processes. We analyzed and compared the available tools for quality monitoring and implementing the necessary corrective measures, thus ensuring continuous improvement in process performance and reliability. This section is crucial for understanding how these tools can be integrated into the FMEA methodology to optimize research outcomes.

10.4 Analysis of Complex Profile Structures in Subsonic Wind Tunnels

This chapter focuses on the analysis of complex profile structures in subsonic wind tunnels, integrated within the doctoral research on the application of the FMEA (Failure Modes and Effects Analysis) method to improve the quality of related processes. By integrating the FMEA method into the analysis of complex profile structures in subsonic wind tunnels, a systematic and proactive approach can be ensured to enhance the quality and reliability of related processes within the doctoral research.

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The process of identifying and evaluating risks in complex profile structures within subsonic wind tunnels is essential to ensure their integrity and performance. This process involves several key stages. By following these stages, the identification and evaluation of risks associated with complex profile structures in subsonic wind tunnels are carried out systematically and comprehensively, thereby contributing to the improvement of the quality and safety of related processes in the doctoral research.

To concretely illustrate the risk identification and evaluation process, we will take the example of a complex profile, such as an advanced aerodynamic profile tested in a subsonic wind tunnel as part of a research project. The goal of this profile, shown in Figure 10.7, is to improve the aerodynamic performance of a new vehicle configuration.

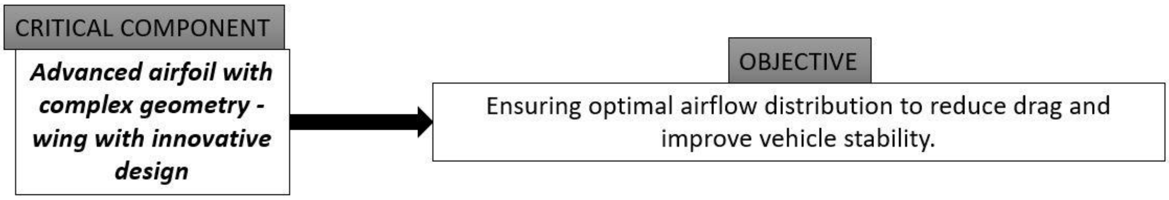

Fig. 10.5 Defining the critical component and objective

The risk identification is presented in Table 10.4.:

Tab. 10.1 Identifying risks in improving aerodynamic performance

No.	Failure mode	Cause	Effect
1	Structural deformation under aerodynamic load.	Aerodynamic loads higher than anticipated, poor material, manufacturing defects.	Degradation of aerodynamic performance, possible airfoil damage during tests, compromise of experimental results.
2	Separation of air flow on the surface of the profile	Non-optimized geometry, rough surfaces, instabilities in the subsonic tunnel.	Increased aerodynamic drag, decreased lift, unexpected vibrations and noises.
3	Cracking and material fatigue.	Repetitive loading cycle, initial defects in the material, lack of adequate heat treatment.	Crack development, potential breakage during testing, need for repairs and re-testing.

Risk assessment is an essential process for identifying, analyzing, and prioritizing potential defects and issues that may arise in the project. This involves determining the likelihood of each risk occurring, evaluating the severity of its consequences, and analyzing the detection capability before the risk causes negative effects. Risk assessment helps improve the quality and reliability of products and processes, thereby contributing to the success of projects and operational safety, as shown in Table 10.5.

Tab. 10.2 Risk assessment in the context of the research topic

Failure mode	S	O	D	RPN
1	7	5	6	210
2	6	6	5	180
3	8	4	4	128

By applying these measures and continuous monitoring, the risks associated with the complex profile tested in subsonic wind tunnels can be significantly reduced, thereby ensuring optimal performance and long-term reliability. This detailed approach underscores the importance of the FMEA method in improving the quality of related processes within the doctoral research.

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The implementation of corrective solutions identified through the FMEA method led to significant improvements in the structural and aerodynamic performance of the wing profile. The reduction of deformation, elimination of cracks, and optimization of airflow contributed to achieving the project objectives, demonstrating the effectiveness of the FMEA methodology in enhancing the quality and reliability of aerodynamic research projects.

11 FINAL CONCLUSIONS, ORIGINAL CONTRIBUTIONS, AND FUTURE RESEARCH DIRECTIONS ON THE DOCTORAL RESEARCH TOPIC

11.1 Final Conclusions

This doctoral thesis explored various aspects of improving the quality of complex profile structures using advanced technical systems, with a particular focus on the aeronautical field. Each chapter of the work contributed to forming a comprehensive understanding of the doctoral research topic.

The first part of the thesis focuses on establishing the theoretical and conceptual foundations of quality and risk management in the aeronautical industry, analyzing essential standards, their importance, as well as the methods and processes that ensure the safety and performance of aeronautical structures.

The second part of the thesis builds on these theoretical foundations and applies them in the context of applied and experimental research, exploring the use of advanced technical systems and cutting-edge technologies to optimize the quality of complex structural profiles. In this part, we transitioned from analyzing and understanding theoretical concepts to the practical implementation of this knowledge, demonstrating how new technologies and methods can improve safety, performance, and efficiency in the aeronautical field.

Chapter 1 provides a detailed overview of the evolution of aviation, highlighting the essential contributions of Romanian pioneers. Their technological innovations laid the foundation for the modern development of both civil and military aviation.

Chapter 2 emphasizes the importance of quality assurance and management concepts in the aeronautical industry. The analysis showed that international standards like ISO 9001 and AS9100 are essential for standardizing quality practices and facilitating collaboration between organizations. It also highlighted the need for adaptability in applying these concepts in the context of rapid technological innovations and strict regulatory requirements.

Chapter 3 underscores the importance of implementing high standards and rigorous methods to improve the quality of scientific research in the aeronautical field. Current quality assurance practices are essential for obtaining accurate and reliable results necessary for developing aeronautical technologies. This chapter laid the theoretical groundwork for the empirical and applied contributions of the doctoral research.

Chapter 4 highlights the importance of risk management and safety in applied aeronautical research. The conceptual and pragmatic approaches to these aspects are crucial for ensuring the safety and reliability of aeronautical systems. The analysis emphasized the need for effective risk management to prevent failures and accidents, as well as to protect the integrity of aeronautical structures.

Chapter 5 underscores the critical role of advanced technical systems in researching and improving the quality of complex profile structures. The use of technologies such as wind tunnels and advanced simulation and testing methods allows for precise and detailed measurements, essential for optimizing structural performance. This chapter highlighted the benefits of these technologies in conducting rigorous assessments and developing innovative solutions for challenges in the aeronautical field.

Chapter 6 provides a synthesis of the current state of knowledge regarding the assurance and improvement of the quality of complex profile structures using advanced technical systems. The analysis emphasizes the importance of implementing strict standards and using advanced technologies to achieve safe and reliable aeronautical structures. The need for close collaboration between researchers, engineers, and regulatory authorities to innovate and optimize quality assurance processes is highlighted.

Chapter 7 clearly presents the research directions, main objective, specific objectives, and methodology used to ensure and improve the quality of complex profile structures. The main objective is to develop and implement innovative solutions for optimizing structural performance. Specific objectives include identifying and applying advanced testing and modeling methods. The proposed research methodology combines theoretical and experimental approaches, using advanced technical systems to ensure the accuracy and efficiency of quality evaluation and improvement processes. The chapter emphasizes the importance of a rigorous and well-structured methodology to obtain relevant and applicable results in the industry.

Chapter 8 details how the combined use of mathematical and experimental methods led to significant improvements in the aerodynamic performance of complex profile structures. Advanced mathematical methods allowed for the modeling and simulation of aerodynamic flow, identifying critical points for optimization. Tests conducted in wind tunnels provided precise data, validating theoretical models and enabling design adjustments. The proposed modifications reduced aerodynamic drag and increased lift, confirming the effectiveness of the solutions through additional tests. The main conclusion is that integrating mathematical approaches with experimental ones is essential for optimizing aerodynamic performance in the aeronautical field.

Chapter 9 explores the application of the Six Sigma method to improve the quality of complex profile structures. Implementing the Six Sigma methodology, using the DMAIC (Define, Measure, Analyze, Improve, Control) approach, allowed for the identification and elimination of variations and defects in manufacturing and testing processes. Detailed analyses led to a deep understanding of the root causes of quality issues. The proposed and implemented optimizations significantly reduced defect rates and improved the uniformity and reliability of structures. The application of this method demonstrated the effectiveness of Six Sigma in achieving more efficient processes and higher-quality products, thereby contributing to the overall improvement of structural performance in the aeronautical field.

Chapter 10 details the application of the FMEA (Failure Modes and Effects Analysis) method to optimize and improve the quality of related processes. The implementation of FMEA allowed for the proactive identification of potential failures and the assessment of their impact on overall performance. Through rigorous analysis of failure modes and their effects, effective preventive measures were proposed and implemented. This approach led to a significant reduction in risks and improved process reliability. The chapter emphasizes that using FMEA is essential for enhancing quality and safety in the development of complex profile structures, demonstrating the benefits of this method within the doctoral research.

11.2 Original Contributions

The first part of the doctoral thesis makes significant contributions to the field of aviation by providing a detailed perspective on the evolution of aviation and highlighting the essential contributions of pioneers. I emphasized the importance of implementing rigorous standards and effective quality management in the aeronautical industry, demonstrating the crucial role of international standards such as ISO 9001 and AS9100. Additionally, I underscored the need to improve the quality of scientific research through the application of rigorous methods and effective management and evaluation strategies, laying the theoretical foundation for the empirical and applied contributions of the thesis. These contributions provide a solid foundation for the exploration and optimization of structural designs in aviation.

In the first chapter, I offered a detailed perspective on the evolution of aviation, highlighting the essential contributions of pioneers such as Traian Vuia, Aurel Vlaicu, and Henri Coandă. The chronological analysis demonstrated how technological advancements and historical achievements influenced the safety, performance, and efficiency of air transportation. The historical context emphasized the importance of continuous innovation and international collaboration in aviation.

Through Chapter 2, I highlighted the importance of implementing rigorous standards and effective quality management to ensure the safety and reliability of aeronautical structures. The analysis showed that international standards, such as ISO 9001 and AS9100, are essential for standardizing quality practices and facilitating collaboration between organizations. The need for adaptability in applying these concepts in the context of rapid technological innovations and strict regulatory requirements was also emphasized.

In Chapter 3, I stressed the importance of implementing high standards and rigorous methods to improve the quality of scientific research. The analysis highlighted the need for effective strategies and tools for managing and evaluating research quality, as well as the importance of continuous adaptation to new challenges and technological opportunities. This chapter laid the theoretical groundwork for the empirical and applied contributions of the doctoral research.

In Chapter 4, I investigated the importance of risk management and safety in applied aeronautical research. This chapter developed and implemented corrective and preventive measures to address identified risks. Additionally, testing processes were optimized to achieve greater operational efficiency and more effective use of resources.

Chapter 5 analyzed the use of wind tunnels and other experimental facilities to improve the quality of structural designs. I assessed the accuracy and quality of design and testing techniques for structural designs in wind tunnels and identified specific aerodynamic parameters obtained through the use of advanced technical systems.

In Chapter 6, I synthesized current knowledge regarding the assurance and improvement of the quality of complex profile structures using advanced technical systems. I identified gaps in current knowledge and highlighted future research opportunities in this field.

The first part of the doctoral thesis explored various aspects of improving the quality of complex profile structures using advanced technical systems, with a particular focus on the aeronautical field. Each chapter of the work contributed to forming a comprehensive understanding of the thesis topic, emphasizing the importance of a systematic and innovative approach to quality assurance and highlighting the crucial role of advanced technical systems in achieving safety and performance objectives.

The second part of this doctoral thesis focuses on the application and evaluation of advanced technical systems to improve the quality of complex profile structures in aviation. The original contributions made in this section are detailed through a series of chapters, each providing innovative perspectives and solutions to current industry challenges.

Chapter 7 makes significant contributions to ensuring and improving the quality of complex profile structures through the use of advanced technical systems. In this chapter, I identified and developed innovative testing and modeling methods, using wind tunnels and other experimental facilities to evaluate and optimize the aerodynamic performance of structures. Additionally, I proposed strategies for integrating simulation and testing technologies to ensure the accuracy and efficiency of evaluation processes, thereby contributing to the improvement of safety and performance in aeronautical structure design. These contributions underscore the importance of a rigorous and well-structured methodology for achieving relevant and applicable results in the industry.

Chapter 8 presents innovative contributions to the analysis of aerodynamic characteristics of standard profiles using advanced experimental and mathematical methods. The research included the development of precise mathematical modeling methods for the aerodynamic flow around symmetric profiles, as well as their testing in wind tunnels for theoretical validation and design adjustment. The use of advanced techniques, such as qualitative airflow visualization, allowed for a better understanding and optimization of aerodynamic performance. The contributions made in this chapter emphasize the integration of mathematical and experimental approaches, leading to significant improvements in aerodynamic drag reduction and increased lift of the studied profiles.

Chapter 9 brings innovative contributions through the application of the "Six Sigma" method to improve the quality of complex profile structures used in doctoral research. The research demonstrated the effectiveness of this method in identifying and reducing variations in design and manufacturing processes, leading to increased consistency and reliability of aeronautical structures. The implementation of "Six Sigma" allowed for process optimization through the use of advanced statistical tools, resulting in significant improvements in structural performance and quality. These contributions highlight the importance of a systematic and rigorous approach to quality assurance in the aviation field.

The doctoral thesis makes important original contributions to the field of aviation and the engineering of complex profile structures:

- Providing a detailed perspective on the evolution of aviation, highlighting the essential contributions of pioneers such as Traian Vuia, Aurel Vlaicu, and Henri Coandă.
- Chronological analysis of the influence of technological advancements and historical achievements on the safety and performance of air transportation.
- Emphasizing the importance of implementing rigorous standards and effective quality management in the aeronautical industry.
- Demonstrating the crucial role of international standards such as ISO 9001 and AS9100 in standardizing quality practices and facilitating collaboration between organizations.
- Highlighting the importance of rigorous methods for improving the quality of scientific research.
- Proposing effective strategies and tools for managing and evaluating research quality.
- Investigating the importance of risk management and safety in applied aeronautical research.
- Developing and implementing corrective and preventive measures to address identified risks.
- Analyzing the use of wind tunnels and other experimental facilities to improve the quality of structural designs.
- Assessing the accuracy and quality of design and testing techniques for structural designs in wind tunnels.
- Synthesizing current knowledge regarding the assurance and improvement of the quality of complex profile structures using advanced technical systems.
- Identifying gaps in current knowledge and highlighting future research opportunities.
- Developing innovative testing and modeling methods using wind tunnels and other experimental facilities.
- Proposing strategies for integrating simulation and testing technologies to ensure the accuracy and efficiency of evaluation processes.
- Analyzing the aerodynamic characteristics of standard profiles using advanced experimental and mathematical methods.
- Developing precise mathematical modeling methods for the aerodynamic flow around symmetric profiles.
- Applying the "Six Sigma" method to improve the quality of complex profile structures.
- Optimizing testing and continuous monitoring processes to improve structural performance.
- Implementing the FMEA (Failure Modes and Effects Analysis) method to optimize and improve the quality of related processes.
- Proactively identifying potential failures and proposing effective preventive measures.

These contributions reflect a systematic and innovative approach in the field of aviation and structural engineering, having a significant impact on the safety and performance of aeronautical structures.aeronautice.

11.3 Future Research Directions

The proposed future research directions focus on technological advancement and enhancing sustainability in the aviation industry. These include exploring advanced materials and composites to create lighter, more durable, and efficient aeronautical structures, as well as utilizing additive manufacturing technologies, such as 3D printing, to reduce the costs and production time of complex components. Additionally, the implementation of intelligent monitoring and maintenance systems, which use sensors and algorithms to anticipate and prevent issues, will ensure greater reliability and safety.

Another important aspect is the optimization of aeronautical structure design through artificial intelligence and machine learning, which can propose innovative solutions to maximize performance while reducing weight and costs. Environmental impact studies will analyze the life cycle of materials and processes, promoting the use of renewable resources and reducing emissions. Furthermore, applying the Lean methodology in production processes will contribute to increasing efficiency and reducing waste, thereby improving the quality and sustainability of final products in the aeronautical industry. These research directions are essential for maintaining high standards of quality and safety, as well as for promoting innovation in aviation.

BIBLIOGRAPHY

Abdus, S., A. H. (2020). *Comparison of Aerodynamic Behaviour between NACA 0018 and NACA 0012 Airfoils at Low Reynolds Number Through CFD Analysis*. Advancement in Mechanical Engineering and Technology, 3(2), https://doi.org/10.5281/zenodo.4003677, 1-8.

Albu, A. (2015). *Modernizarea forțelor aeriene: Tehnologii și strategii*. București: Editura Militară.

Alieva, D. K. (2022). *Hysteresis of the aerodynamic characteristics of NACA 0018 airfoil at low subsonic speeds*. Thermophys. Aeromech., 29, 43–57 (2022). https://doi.org/10.1134/S0869864322010036.

Al-Waily, M. (2013). *Experimental and Numerical Vibration Study Of Woven Reinforcement Composite Laminated Plate With Delamination Effect*. International Journal Of Mechanical Engineering, Iaset, 2(5).

António, M. G. L., J. A. (2022). *Numerical simulation of the aerodynamic characteristics of the NACA 0018 airfoil at medium range Reynolds number*. Wind Engineering, Volume 46, Issue 6, DOI:10.1177/0309524X221102968.

Apostol, E. I., Țîțu, A. M., (2023). *Numerical studies on aerodynamic performace of NACA 0018 profile in fundamental and research application of the aerospace industry*. International Conference on Applied Sciences 2023, J.Phys.:Conf.Ser.: 2540012001, Banja Luka, Bosnia and Herzegovina, In: Journal of Physics: Conference Series, Volume 2540, DOI 10.1088/1742-6596/2540/1/012001 https://iopscience.iop.org/article/10.1088/1742-6596/2540/1/012001/meta, (Revista SCOPUS).

Apostol, E. I., Țîțu, A. M., Tertereanu, P., Moisescu, I., (2022). *Specific aspects of quality and safety management in aerospace field*. The 16th International Management Conference, Management and Resilience Strategies for a Post-Pandemic Future, IMC 2022, In: PROCEEDINGS OF THE 16th INTERNATIONAL MANAGEMENT CONFERENCE, DOI: 10.24818/IMC/2022/01.01)http://conference.management.ase.ro/archives/2022/pdf_IMC_2022/1_1.pdf (Conferința și Proceedings BDI).

Apostol, E. I., Bălașa, R., (2022). *Improving the performance of an aerodynamic profile by testing in the subsonic wind tunnel*. International Conference "New Technologies, Development and Applications", In: Karabegović, I., Kovačević, A., Mandžuka, S. (eds) New Technologies, Development and Application V. NT 2022. Lecture Notes in Networks and Systems, vol 472. Springer, Cham https://doi.org/10.1007/978-3-031-05230-9_9 , (Proceedings BDI, SCOPUS, În curs de indexare WOS).

Apostol, E. I., Doicin, C. V., Ionescu, N., Țîțu, A. M., (2023). *Nonconventional technologies in the modern world of aviation*. The 22nd International Conference of Nonconventional Technologies, ICNcT Conference 2023, http://artn.ro/conference2023/ In: Nonconventional Technologies Review, Vol 27, No 3, (2023) https://www.revtn.ro/index.php/revtn/article/view/428, (Revista BDI).

Apostol, E. I., Doicin, C. V., Ionescu, N., Țîțu, A. M., (2023). *Perspectives regarding the evolution of aerospace safety management in extreme weather conditions*. The 17th International Management Conference, Management and Resilience Strategies for a Post-Pandemic Future, IMC 2023, http://conferinta.management.ase.ro/, In: PROCEEDINGS OF THE 17th INTERNATIONAL MANAGEMENT CONFERENCE, DOI: 10.24818/IMC/2023/01.01, https://conference.management.ase.ro/archives/2023/pdf_IMC2023/S1/1_1.pdf (Conferință și Proceedings BDI).

Apostol, E. I., Dragomir, D., Țîțu, A. M, (2021). *Specific aspect of quality assurance and management in the aerospace field*. ACTA TECHNICA NAPOCENSIS - Series: APPLIED MATHEMATICS, MECHANICS, And ENGINEERING, [S.l.], v. 64, n. 4s, dec. 2021. ISSN 2393–2988, WOS:000740057300002 (Revistă ISI-ESCI).

Apostol, E. I., Țîțu, A. M., (2023). *CFD simulation of the aerodynamic characteristics of the NACA 0018 symmetrical airfoil*. International Symposium for Production Research, Antalya 2023, In: Durakbasa, N.M., Gençyılmaz, M.G. (eds) Industrial Engineering in the Industry 4.0 Era. ISPR 2023. Lecture Notes in Mechanical Engineering. Springer, Cham.,https://doi.org/10.1007/978-3-031-53991-6_32 https://link.springer.com/chapter/10.1007/978-3-031-53991-6_32, (Proceedings BDI, SCOPUS, În curs de indexare WOS).

Apostol, E. I., Țîțu, A. M., (2023). *Mathematical simulation of the aerodynamic characteristics of the NACA 0018 symmetrical airfoil with flaps*. Technical University of Cluj, Acta Technica Napocensis – Series: Applied Mathematics, Mechanics and Engineering, Volume 66, Issue 3, Page 437-444, 2023, WOS:001106401600005, https://atna-mam.utcluj.ro/index.php/Acta/article/view/2195 (Revistă ISI-ESCI).

Apostol, E. I., Țîțu, A. M., (2024). *Enhancing the quality of aeronautical scientific research: a pathway to innovation and progress*. 4th ICPR AEM Poznań 2024Moving to New Production Research and Management Paradigms 28 June - 3 July 2024, https://aeme-cpr.put.poznan.pl, https://aeme-cpr.put.poznan.pl/wp-content/uploads/2024/07/ICPR-AEM-2024_preliminary-program_final.pdf (Conferință BDI, În curs de publicare).

Apostol, E. I., Țîțu, A. M., (2024). *Risk management applied to qualitative airflow visualization methods in wind tunnels*. In: Revista de Management si Inginerie Economica, Vol. 23, No. 2(92), June 2024, p. 176 - 187, ISSN (print): 1583-624X, ISSN (online): 2360-2155 https://www.rmee.org/abstracturi/92/08_Articol_703_v3.pdf (Revista BDI).

Apostol, E. I., Țîțu, A. M., (2024). *Swot analysis of simulation methods and visualisation of airflow in subsonic wind tunnels*. In: Journal of Research and Innovation for Sustainable Society (JRISS), Tg. Jiu, Romania, Volume x, Nr. x, 2024, ISSN: 2668-0416, Thoth Publishing House, DOI: x; Pages 139-148; https://jriss.4ader.ro/, (Revista BDI, În curs de publicare).

Apostol, E. I., Țîțu, A. M, (2024). *Review of qualitative experimental methods for visualising airflow around aircraft mock-ups in wind tunnels*. In: Journal of Research and Innovation for Sustainable Society (JRISS), Tg. Jiu, Romania, Volume x, Nr. x, 2024, ISSN: 2668-0416, Thoth Publishing House, DOI: x; Pages 139-148; https://jriss.4ader.ro/, (Revista BDI, În curs de publicare).

Armaan, A., S. G. (2019). *The numerical analysis of NACA 0018 airfoil*. International Journal of Mechanical and Production, ISSN(P): 2249-6890; ISSN(E): 2249-8001, Vol. 9, Issue 4,1047-1054.

Aven, T. (2015). *Risk Analysis*. John Wiley & Sons, ISBN: 978-1119056621.

Avram, V. (2012). *Istoria aviației militare românești*.

Awadh, K., R. J. (2018). *Study And Design Of Golf Ball Like Dimpled Aircraft 2-D Wing And Effect On Aerodynamic Efficiency*, Proceedings Of The International Conference On Modern Research On In Aerospace Engineering.

Awasthi, M., D. J. (2018). *Flow Structure Of A Low Aspect Ratio Wall-Mounted Airfoil Operating In A Low Reynolds Number Flow*, Exp. Therm. Fluid Sci., Vol. 99, No. October 2017, Pp. 94–116.

Ayra, E.S. (2013). *Risk Analysis and Safety Decision-Making in Commercial Air Transport Operations*.

Banabic, D., (2020). *Istoria tehnicii şi a industriei româneşti*. Bucureşti : Editura Academiei Române, 2020 2 vol. ISBN 978-973-27-2992-2.

Barker, E. (2002). *Aerospace AS9100 QMS Standard*.

Bădescu, V., & Moșneagu, D. (2020). *Advances in aerospace engineering*. Springer. doi:10.1007/978-3-030-12345-7.

Bălașa, R., Costea M.L., Andrei, A.G., **Apostol E.I.**, A. Semenescu, A., 2021, *A dynamic approach to wind tunnel testing under risk conditions assessment*, International Conference on Applied Sciences (ICAS 2021), In: Journal of Physics:Conference Series, Volume 2212, Conf. Ser. 2212 012007, https://iopscience.iop.org/article/10.1088/1742-6596/2212/1/012007 (Revistă SCOPUS)

Bălașa, R., Costea M.L., Andrei, A. ., **Apostol E.I.**, A. Semenescu, A., 2020, *Air fleet endowment using methods of decision under certainty*, International Conference on Applied Sciences (ICAS 2020) 20-22 May 2020, Hunedoara, Romania, In: Journal of Physics: Conference Series, Volume 1781, Conf, Ser. 1781 012070, https://iopscience.iop.org/article/10.1088/1742-6596/1781/1/012070, (Revistă SCOPUS)

Benea, B. (2013). *Pionierii aviației românești*.

Best, S., Bari, G., Brooker, T., Flynt, G., & Walter, J. (2023). *The Honda Automotive Laboratories of Ohio Wind Tunnel*. SAE International Journal of Advances and Current Practices in Mobility, 5(6), 2116-2137. https://doi.org/10.4271/2023-01-0656.

Boschetti, P., Cárdenas, E., & Amerio. (2005). *Aerodynamic optimization of an UAV Design*. 5th Aviation Technology Integration and Operation. Arlington, Virginia: DOI: 10.2514/6.2005-7399.

Branislav, T., V. S.-B. (2011). *Quality management system for the aerospace industry*, Toronto.

Brown, M. (2019). *Aviation security: Next steps*, International Journal of Aviation, Aeronautics, and Aerospace, https://commons.erau.edu/ijaaa/vol5/iss2/6/.

Carr, L., Mcalister, K., & Mccroskey, W. (2016). *Analysis of the development of dynamic stall based on oscillating airfoil experiments, NASA TN D-8382*, Ames Research Center and U.S. Army Air Mobility R&D Laboratory Moffett Field, Calif. 94035. Available online: https://ntrs.nasa.gov/search.jsp?R=19770010056.

Cecilia, R. Aragon and Marti A. Hearst, (2005). *Improving aviation safety with information visualization: a flight simulation study*. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '05). Association for Computing Machinery, New York, NY, USA, 441–450. https://doi.org/10.1145/1054972.1055033.

Chanetz, B., Délery, J., Gilliéron, P., Gnemmi, P., Gowree, E. R., & Perrier, P. (2020). *Wind Tunnels and Other Aerodynamic Test Facilities*. In Experimental Aerodynamics (pp. 23-45). Springer. https://doi.org/10.1007/978-3-030-35562-3_2.

Childs, R., P. Stremel , V. Hawke , J. Garcia , W. L. Kleb , C. Hunter , P. Parikh , and e al, (2021). *Flow characterization of the NASA Langley unitary plan wind tunnel, test section 2: Computational results*, AIAA Paper No. 2021-2963, 2021.

Ciobanu, I. (2018). *Tehnologii avansate în aviația militară modernă*. Cluj-Napoca: Editura Universității Tehnice.

Courteau M. R., (2013). *Les perspectives d'évolution de l'aviation civile à l'horizon 2040 : Préserver l'avance de la France et de l'Europe.*

Cook, G. N., & Billig, B. G. (2017). *Airline Operations and Management: A Management Textbook*. Routledge.

Dale, G. (2010). *AS9100 Aerospace Requirements.*

Devi, B., D. A. (2017). *Computational Analysis of Cavity Effect over Aircraft wing*, World Engineering & Applied Sciences Journal, 8(2), pp 104-110.

El-Amin, A. (2023). *Zero-Defect Manufacturing Utilizing Autonomation in Aerospace*, SME.

Eldho, S.J., A. S. (2017). *Comparative Study of Boundary Layer Control Around an Ordinary Airfoil and a High Lift Airfoil with Secondary Blowing*, Computional Fluids, 164, pp 50-63.

Eleni, D., A. T. (2012). *Evaluation of the turbulence models for the simulation of the flow over a National Advisory Committee for Aeronautics (NACA) 0012 airfoil*, Mechanical Engineering Research, 4(3), pp. 100-111.

Floyd, M. (2012). *Enterprise risk management: A practical approach to modern risk management*. Kogan Page.

Franzke, R, Sebben, S, Willeson, E., (2022). *Experimental investigation of the air flow in a simplified underhood environment.* Proceedings of the Institution of Mechanical Engineers, Part D: Journal of Automobile Engineering. 2022;236(10-11):2272-2282. doi:10.1177/09544070211059786.

Gao, Nan & Liu, X. H.. (2018). *An improved smoke-wire flow visualization technique using capacitor as power source*. Theoretical and Applied Mechanics Letters. 8. 378-383. 10.1016/j.taml.2018.06.010.

Garg, P., & Soni, N. (2016). *Aerodynamic investigation of flow field over NACA 4415 airfoil*, Int. J. Adv. Res. Sci. Eng. Tech. 2016, 03, Issue 2 , 1506-1512.

Gaspar, M., L., S. P. (2018). *Defining Strategic Quality Directions based on Organisational Context Identification*; Case Study in a Software Company. Cluj-Napoca.

Genc, M. S. (2020). *Traditional and New Types of Passive Flow Control Techniques to Pave the Way for High Maneuverability and Low Structural Weight for UAVs and MAVs*, IntechOpen.

Gerede, E. (2015). *"A qualitative study on the exploration of challenges to the implementation of the safety management system in aircraft maintenance organizations in Turkey."*, Journal of Air Transport Management.

Gerontakos, P.,&Lee, T.(2008). *PIV study of flow around unsteady airfoil with dynamic trailing-edge flap deflection*, Exp. Fluids 2008, 45:955 doi:10.1007/s00348-008-05144.

Guo, H., Li, G., & Zou, Z. (2022). *Numerical Simulation of the Flow around NACA0018 Airfoil at High Incidences by Using RANS and DES Methods*, J. Mar. Sci. Eng. , 10, 847. https://doi.org/10.3390/jmse10070847.

Helmold, M. (2023). *Total Quality Management (TQM)*. In: Virtual and Innovative Quality Management Across the Value Chain. Springer. doi:10.1007/978-3-031-30089-9_4.

Hollnagel, E. (2004). *Barriers and Accident Prevention*. Aldershot:Ashgate.

Howell, C. (2020). *What Is Difference between Hazard and Risk in Aviation SMS*, SMS Pro Aviation Safety Software Blog 4 Airlines & Airports.

Hubbard, D. W. (2020). *The Failure of Risk Management: Why It's Broken and How to Fix It (2nd ed.).* John Wiley & Sons, ISBN: 978-1119522034.

Ikegaya, N., H., Kikumoto, K., Sasaki, S., Yamada, M., Matsui, (2022). *Applications of wide-ranging PIV measurements for various turbulent statistics in artificial atmospheric turbulent flow in a wind tunnel*, Building and Environment, Volume 225, 2022, 109590, ISSN 0360-1323, https://doi.org/10.1016/j.buildenv.2022.109590.

Ionescu, S. (2019). *Strategii de modernizare a flotei aeriene: O analiză a forțelor aeriene române*. Timișoara: Editura Universității de Vest.

Jan, M., K. R. (2022). *Numerical Study of the Effect of the Reynolds Number and the Turbulence Intensity on the Performance of the NACA 0018 Airfoil at the Low Reynolds Number Regime,* Advancement in Computational Fluid Mechanics and Optimization Methods, 10(5), 1004; https://doi.org/10.3390/pr10051004.

Janour, Z. , K., Jurcakova, K., Brych, F., Dittrt, F., Dittrich, (2010). *Potential risks at an industrial site: A wind tunnel study*, Process Safety and Environmental Protection, Volume 88, Issue 3, 2010, Pages 185-190, ISSN 0957-5820, https://doi.org/10.1016/j.psep.2010.01.003.

Jianping, Niu, J. L. (2018). *Numerical research on the effect of variable droop leading-edge on oscillating NACA 0012 airfoil dynamic stall*, Aerospace Science and Technology, 72, pp. 476-485. doi:https://doi.org/10.1016/j.ast.2017.11.030.

Johnson, C. (2008). *Military Risk Assessment in Counter Insurgency Operations: A Case Study in the Retrieval of a UAV Nr Sangin*, Proceedings of the Third IET Systems Safety Conference. Birmingham.

Juran, J. M. (1980). *Quality Planning and Analysis*. New York: Mc Graw-Hill.

Katam, V. (2005). *Simulation of low-Re flow over a modified NACA 4415 airfoil with oscillating camber. aster's Thesis*, University of Kentucky, 2005, Lexington, Kentucky, U.S., Paper 339.

Kearns, S. K. (2018). *Fundamentals of international aviation*. Routledge. ISBN: 978-1138708972,https://news.mcaa.gov.mn/uploads/bookSubject/202203/6242b2afb081b.pdf.

Khare, A., S. A. (2009). *Best Practices in Grid Generation for CFD Applications Using HyperMesh*, Computational Research Laboratories.

Kivits, R., Charles, M. B., & Ryan, N. (2010). *A Post-carbon Aviation Future: Airports and the Transition to a Cleaner Aviation Sector*. Futures, 42(3), 199-211.

Kroo, I. (2005). *Innovation in Aerodynamic Design: Reducing the Environmental Impact of Aviation.* Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences, 363(1836), 2907-2919.

Lacaze, Henri (2016). *Les avions Louis Breguet Paris* [The Aircraft of Louis Breguet, Paris] (in French). Vol. 2: le règne du monoplan. Le Vigen, France. ISBN 978-2-914017-89-3.

Latorella, K.A. & Prabhu, P.V. (2000). *"A review of human error in aviation maintenance and Inspection."*, International Journal of Industrial Ergonomics.

Lazur, B. I., Jagadeesh, L., Karthikeyan, B., & Shanmugaraja, M. (2014). *An Approach to Improve Aviation Quality Management Using Total Quality Management Principles*. In: Innovative Design, Analysis and Development Practices in Aerospace and Automotive Engineering. Springer, New Delhi. doi:10.1007/978-81-322-1871-5_11.

Leveson, N. (2004). *A new accident model for engineering safer systems*. Safety Science.

Livy, E., V. A. (2015). *Aerodynamic Analysis of Dimpled Effect on Aircraft Wing*, International Journal of Mechanical Aerospace Industrial Mechatronics and Manufacturing Engineering, 9(2), pp. 350-353.

Llorca, I. (2015). *CFD analysis and assessment of the stability and control of a supersonic business jet.* Royal Institute of Technology (Kth), Stockholm, Sweden, 2015.

Luca, D., M. F. (2023). *Influence of free-stream turbulence intensity on static and dynamic stall of a NACA 0018 aerofoil*, Journal of Wind Engineering & Industrial Aerodynamics, Volume 232, 105270.

Lundvall, B.-Å. (2010). *National Systems of Innovation: Toward a Theory of Innovation and Interactive Learning*. Anthem Press. ISBN: 978-1843318668.

Machacek, M., and T. Rosgen,(2001). *Development of a quantitative flow visualization tool for applications in industrial wind tunnels*, ICIASF 2001 Record, 19th International Congress on Instrumentation in Aerospace Simulation Facilities (Cat. No.01CH37215), Cleveland, OH, USA, 2001, pp. 125-134, doi: 10.1109/ICIASF.2001.960242.

Marshall, G. B., & Rossman, C. (2006). *Designing qualitative research (4th ed.)*. Thousand Oaks, CA: Sage.

Mascia, A., Cirafici, A.M., Bongiovanni, A. et al., (2020). *A failure mode and effect analysis (FMEA)-based approach for risk assessment of scientific processes in non-regulated research laboratories*. Accred Qual Assur 25, 311–321 (2020). https://doi.org/10.1007/s00769-020-01441-9.

Matsson, J.E., M. C. (2016). *Aerodynamic Performance of the NACA 2412 Airfoil at Low Reynolds Number*. ASSE 23rd Annual Conference.

May, G., & Kiritsis, D. (2019). *Zero Defect Manufacturing Strategies and Platform for Smart Factories of Industry 4.0*. In: Monostori, L., Majstorovic, V.D., Hu, S.J., Djurdjanovic, D. (eds). Springer. doi:10.1007/978-3-030-12345-7.

Mayank, P., Z. S. (2017). *Experimental Analysis of Flow Over Symmetrical Aerofoil*. Chandubhai S. Patel Institute of Technology, 8-12.

McAurthur, J. (2008). *Aerodynamics of Wing at Low Reynolds Numbers: Boundary Layer Separation and Reattachment*. Doctor of Philosophy Dissertation, Dept. of Aerospace and Mechanical Engineering, Univ. Of Southern California, Los Angeles, CA, 2008.

Megson, T. H. G. (2017). *Aircraft Structures for Engineering Students*. Butterworth-Heinemann.

Merlijn, De Paepe, Jan, G. Pieters, Wim, M. Cornelis, Donald, Gabriels, Bart, Merci, Peter, Demeyer, (2013). *Airflow measurements in and around scale-model cattle barns in a wind tunnel: Effect of wind incidence angle*, Biosystems Engineering, Volume 115, Issue 2, 2013, Pages 211-219, ISSN 1537-5110, https://doi.org/10.1016/j.biosystemseng.2013.03.008.

Moffett (Ed.). (2005). *Test Planning Guide for High Speed Wind Tunnels A027-9391-XB2.* California: Technical Publication Group for The wind Tunnel Division, Ames Research Center.

Moisescu I., **Apostol E. I.**, Tertereanu P., Țîțu A.M., 2022, *Elaborating processes map for a central public authority*, Technical University of Cluj, Acta Technica Napocensis – Series: Applied Mathematics, Mechanics and Engineering, Vol. 65, No. 4s, 2022, **WOS:000936379500009**, (Revistă ISI-ESCI), https://atna-mam.utcluj.ro/index.php/Acta/article/view/2006

Morshed, K. (2010). *Experimental and numerical investigations on aerodynamic characteristics of savonius wind turbine with various overlap ratios*. Master of Science in Applied Engineering, Georgia Southern University , Statesboro, Georgia 30458 , 2010.

Mueller, T. J. (2003). *Aerodynamics of Small Vehicles*. Annual Review of Fluid Mechanics, Vol. 35, No. 1, 2003, pp. 89–111.

Munson, B. Y. (2006). *Fundamentals of Fluid Mechanics*. Wiley, 5th ed.

Myhrberg, E. &. (2006). *A practical field guide for AS9100*. Milwaukee.

Nasser, Eddegdag et al, (2023*). Investigation of viscous supersonic laminar flows around F-16 airfoil: experimental, numerical, and analytical approaches*, Phys. Scr. 98 125009, DOI 10.1088/1402-4896/ad0580.

O'Connell, J. F., & Williams, G. (Eds.) (2016). *Air Transport in the 21st Century: Key Strategic Developments*. Routledge.

Ohtake, T. N. (2007). *Nonlinearity of the Aerodynamic Characteristics of NACA 0012 Aerofoil at Low Reynolds Numbers.* Japanese Society for Aeronautical and Space Science Papers, Vol. 55, No. 644, 2007, pp. 439–445. doi:10.2322/jjsass.55.439.

Oprean, C., Ț. M. (2008). *Managementul calității în economia și organizația bazate pe cunoștințe.* București: Editura AGIR, ISNB 978-873-720-167-6.

Oprean, C., Ț. M. (2011). *Managementul global al organizației bazată pe cunoștințe*. București: Editura AGIR, ISBN 978-973-720-363-2.

Oprean, C. K. (2002). *Managementul calității*. Editura ULBS.

Peerzada, K. (2023). *Unsteady aerodynamics of stationary and plunging*, APPLIED SCIENCES OF MIDDLE EAST TECHNICAL UNIVERSITY.

Peeters, P., Higham, J., Kutzner, D., Cohen, S., & Gössling, S. (2016). *Are Technology Myths Stalling Aviation Climate Policy?*, Transportation Research Part D: Transport and Environment, 44, 30-42.

Philip, S. A., Philip, A. L., Flint, O Thomas, Sergey, B. Leonov, (2024). *Visualization of sidewall vortices in rectangular nozzle supersonic blowdown wind tunnel*. Physics of Fluids 1 January 2024; 36 (1): 016136. https://doi.org/10.1063/5.0180727.

Popescu, A. (2020). *Economia bazată pe cunoaștere și impactul asupra dezvoltării regionale.* Editura Universitară. ISBN: 978-973-749-693-2.

Popescu, M., & Vasilescu, L. (2020). *Evoluția și modernizarea aviației militare românești*. Iași: Editura Academiei Militare.

Prasath, M. S, I. A. (2017). *Effect of Dimples on Aircraft Wing*. GRDJE, 2(5), pp 234-242.

Ragnhild, J. E., D. O. (2016). *A guideline of quality steps towards Zero Defect Manufacturing in Industry*, Norway.

Ragnhild, J. E., D. O. (2016). *A guideline of quality steps towards Zero Defect Manufacturing in Industry*. Norway.

Ragni, D., Ferreira, C., & Correale, G. (2014). *Experimental investigation of an optimized airfoil for vertical-axis wind turbines*. Wind Energ. 2014. Doi: 10.1002/We.17805.

Rajasai, B., R. T. (2015). *Aerodynamic effects of dimple on aircraft wings*, Int. J. Adv. Mech. Aero. Engg., 2(2), pp 169-172.

Rathod, N. U. (2014). *Aerodynamic Analysis of a Symmetrical Aerofoil*. Department of Mechanical, BMS college of Engineering, 3971-3981.

Ravikumar, T., P. S. (2014). *Aerodynamic analysis of supercritical NACA SC(2)-0714 airfoil using CFD*. Int. J. Adv. Tech. Eng. Sci., 285-293.

Reason, J. (2008). *The Human Contribution: Unsafe Acts, Accidents and Heroic Recoveries*. Surrey: Ashgate.

Rodríguez-Sevillano, Á. A.; C. C., M. J. , B. M., R., B. G., L., M. G. Z., L., L. C. A., A., F. A., J., M. G, J.C., B. B., E., (2023). *Exploring the Effectiveness of Visualization Techniques for NACA Symmetric Airfoils at Extremely Low Reynolds Numbers*. Fluids 2023, 8, 207. https://doi.org/10.3390/fluids8070207.

Romeo, Giulio & Borello, F. & Correa, G. & Cestino, E.. (2013). *ENFICA-FC: Design of transport aircraft powered by fuel cell & flight test of zero emission 2-seater aircraft powered by fuel cells fueled by hydrogen.* International Journal of Hydrogen Energy. 38. 469–479. 10.1016/j.ijhydene.2012.09.064.

Ruchała, R. P. (2018). *The Flow Separation Development Analysis In Subsonic And Transonic The Flow Separation Development Analysis In Subsonic And Transonic Flow Regime Of The Laminar Airfoil Flow Regime Of The Laminar Airfoil*. Transp. Res. Procedia, Vol. 29, Pp. 323–329.

Sabnis, K., H., Babinsky , D. S., Galbraith , and J. A., Benek , (2021). *Nozzle geometry-induced vortices in supersonic wind tunnels*, AIAA J. 59(3), 1087–1098 (2021).https://doi.org/10.2514/1.J059708.

Saraf, A. K., S. M. (2017). *Effect of Dimple on Aerodynamic Behaviour of Airfoil*. International Journal of Engineering and Technology, 9(3), pp 2268-2277.

Sarkar, S., M. S. (2017). *CFD Analysis of Effect of Variation in Angle of Attack over NACA 2412 Airfoil through the Shear Stress Transport Turbulence Model*. International Journal for Scientific Research & Development, 5(2).

Schmidt, R., & Gross, L. (2014). *Aircraft Structural Design: A Conceptual Approach*. Journal of Aircraft, 51(3), 871-882.

Shrestha, R. B. (2016). *Hover Performance of a Small-Scale Helicopter Rotor for Flying on Mars*. Journal of Aircraft, Vol. 53, No. 4, 2016, pp. 1160–1167. doi:10.2514/1.C033621.

Siauw, W.L., B. J. (2017). *Transient phenomena in separation control over a NACA 0015 airfoil*. International Journal of Heat and Fluid Flow, V. 67(Part B), pp 23-29. doi:https://doi.org/10.1016/j.ijheatfluidflow.2017.03.008.

Siva, V. (2015). *Analysis of ground effect on a symmetrical airfoil*. Int. J. Eng. Res. App. 2015, 5, Issue 10, (Part - 2), 40-42.

Smith, I. (2023). *The crucial role of wind tunnel testing in advancing aviation*. Aerospace Testing International, https://www.aerospacetestinginternational.com/features/the-crucial-role-of-wind-tunnel-testing-in-advancing-aviation.html.

Sprycha, I. (2013). *Aerospace quality management system*, Poland.

Srinivas, A. A. (2018). *In Tune With Times : Recent Developments In Theoretical, Experimental And Numerical*. TJPRC Publication, Vol. 7, No. 2, Pp. 805–816.

Srinivas, A. A., (2014). *Aerodynamic Performance Comparison Of Airfoils By Varying Angle Of Attack Using Fluent*. TJPRC Publication, Vol. 594, Pp. 1889–1896.

Srinivasa, T., T. M. (2018). *Enhancement Of Lift-Drag Characteristics Of Naca 0012*. Mater. Today Proc, Vol. 5, No. 2, Pp. 5328–5337.

Stolzer, A. J., Halford, C. D., & Goglia, J. J. (2008). *Safety Management Systems in Aviation*. Ashgate Publishing, ISBN: 978-0754674009.

Stoica, C., Manea M., Trandafir E., **Apostol E. I.**, Nica A., Bălașa R., Pană A., Curt D., Defta S., Pîrvu C., 2023, *Wind Tunnel Testing of a Common Research Model*, 2023, Session: Special Session: INCAS Research Challenges in Aerospace Technologies, In: AIAA SCITECH 2023 Forum, National Harbor, American Institute of Aeronautics and Astronautics, AIAA 2023-1017, DOI:10.2514/6.2023-1017, https://arc.aiaa.org/doi/10.2514/6.2023-1017 (Meeting Paper, Proceeding BDI)

Stone, L. D., C. M. (2013). *Search for the Wreckage of Air France Flight AF 447*, Statistical Science.

Su, E., Randall, R, Wilson, L, Shkarayev, S., (2017). *Visualization of vortical flows around a rapidly pitching wing and propeller*. International Journal of Micro Air Vehicles. 2017;9(1):25-43. doi:10.1177/1756829316685189.

Sukhikh, N.N., D. Y. (2017). *Risk Factors Management for Flight Safety Improvement Purposes*. Revista ESPACIOS 38.

Swamy, N.V.N., S. P. (2020). *A study of high lift aerodynamic devices on commercial aircraftS*. Aviation,, 24(3), 123-136. https://doi.org/10.3846/aviation.2020.12815.

Şahin, Ö. (2022). *The effects of flap extension time on the fuel burn of commercial aircraft*. Aircraft Engineering and Aerospace Technology, ISSN: 0002-2667, Vol. 94 No. 10, pp. 1825-1833. https://doi.org/10.1108/AEAT-05-2021-0148.

Tan, H., Wong, K.Y., Othman, M.H.D. et al., (2022). *Current and potential approaches on assessing airflow and particle dispersion in healthcare facilities: a systematic review*. Environ Sci Pollut Res 29, 80137–80160 (2022). https://doi.org/10.1007/s11356-022-23407-9.

Tavakol, M. M. & Yaghoubi, M. & Ahmadi, Goodarz. (2020). *Experimental and numerical analysis of airflow around a building model with an array of domes*, Journal of Building Engineering. 34. 101901. 10.1016/j.jobe.2020.101901.

Tavares, S. M., de Castro, P. M. S. T., & Moreira, P. M. G. P. (2013). *Structural Health Monitoring of Aerospace Composites: Challenges for Implementation*. Structural Health Monitoring, 12(4), 317-328.

Teeab, T., M. A. (2022). *Performance Analysisof H-Darrieus Wind Turbinewith NACA0018 and S1046 Aerofoils: Impact of Blade Angle and TSR*. CFD Letters, 14, Issue 2(2022) 10-23, ISSN: 2180-1363.

Tertereanu, P., Țîțu A.M., **Apostol E. I.**, I. Moisescu, 2022, *Management of organizational change in public institutions in the dynamics of internal and external security transformation*, 10th edition of Strategica International Conference, Sustainable

Development and Strategic Growth, pg. 636-646, 2022, https://strategica-conference.ro/conference-proceedings-repository/, (Proceedings BDI)

Thimmegowda, H., Krishnan, Y. (2021). *Computational and Experimental Study on Flow Quality of Open-Loop Low-Speed Wind Tunnel*. International Journal of Engineering and Technical Research. 10. 567-572.

Thomson, N. and J., Rocha, (2021). *Comparison of semi-empirical single point wall pressure spectrum models with experimental data*, Fluids 6(8), 270 (2021).

Thysen, J.H., van Hooff, T., Blocken, B., & van Heijst, G. J. F. (2022). *PIV measurements of opposing-jet ventilation flow in a reduced-scale simplified empty airplane cabin*. European Journal of Mechanics. B, Fluids, 94, 212-227. https://doi.org/10.1016/j.euromechflu.2022.03.001.

Tomescu, N.Ș., C. D. (2000). C*onsideraţii privind managemantul calitatii*. Bucuresti.

Trinder, M., Jabbal, M., (2013). *Development of a Smoke Visualisation System for Wind Tunnel Laboratory Experiments*. International Journal of Mechanical Engineering Education. 013;41(1):27-43. doi:10.7227/IJMEE.41.1.5.

Tsuchiya, T.N. (2013). *Influence of Turbulence Intensity on Aerodynamic Characteristics of anNACA0012 at Low Reynolds Numbers*. 51st AIAA Aerospace Sciences Meeting, AIAA Paper 2013-65, Jan. 2013. doi:10.2514/6.2013-65.

Țîțu, A. M., B. V. (2008). *Economia organizațiilor industriale moderne*. Sibiu: Editura ULBS.

Țîțu, A. M., O. C. (2011). *Cercetarea experimentală aplicată în creșterea calității produselor și serviciilor*. București: Editura AGIR, ISBN 978-973-720-362-5.

Țîțu, A. M. (2007). *Managementul calității în organizațiile industriale moderne, Teză de doctorat*. Sibiu: Universitatea Lucian Blaga din Sibiu.

Țîțu, A.M. & Cupșan, V.C. (2022). *"Breakdown of the Product Quality Assurance Flow Within the Advanced Product Quality Planning (APQP) Methodology in the Aerospace Industry."* ,Springer, Cham.

Ţîţu, A. M., & Oprean, C. (2006). *Cercetarea experimentală şi prelucrarea datelor*. Partea I. Sibiu: Editura Universităţii „Lucian Blaga” din Sibiu.

Ţîţu, A. M., & Oprean, C. (2007). *Managementul calităţii*. Piteşti: Editura Universităţii din Piteşti.

Ţîţu, A. M., & Oprean, C. (2007). *Managementul strategic*. Piteşti: Editura Universităţii din Piteşti.

Ţîţu, A. M., & Oprean, C. (2015). *Management of intangible assets in the context of knowledge based economy*. Germania: LAP Lambert.

Țîțu, A. M., Oprean, C., & Boroiu, A. (2011). *Cercetarea experimentală aplicată în creșterea calității produselor și serviciilor.* București: AGIR.

Ţîţu, A. M., Oprean, C., & Cicală, E. (2001). *Tehnici şi metode în conducerea proceselor tehnologice*. Sibiu: Editura Universităţii „Lucian Blaga” din Sibiu.

Țîțu, A. M., Oprean, C., & Tomuță, I. (2007). *Cercetarea experimentală şi prelucrarea datelor*. Studii de caz. Sibiu: Editura Universităţii „Lucian Blaga” din Sibiu.

Țîțu, A. M., Pop, A. B., & Țîțu, Ș. (2018). *The correlation between intellectual property management and quality management in the modern knowledge-based economy*. In 2018 10th International Conference on Electronics, Computers and Artificial Intelligence (ECAI), 1-6.

Țîțu A.M., Olteanu C., Dragomir M., **Apostol E. I.**, 2024, *Current and prospective trends in improving the quality of information processes within a public service organization to citizens*, 4th ICPR AEM Poznań 2024 Moving to New Production Research and Management Paradigms 28 June – 3 July 2024, https://aeme-cpr.put.poznan.pl, https://aemecpr.put.poznan.pl,https://aemecpr.put.poznan.pl/wpcontent/uploads/2024/07/ICPR-AEM-2024_preliminary-program_final.pdf, In: Proceeding EcoProduction, e ISSN 2193-4622, Print ISSN 2193-4614, SPRINGER, https://www.springer.com/series/10152 (Conferință BDI, SCOPUS, Proceeding WOS, în curs de indexare, în curs de publicare)

Umapathi, M., & Soni, N. (2015). *Comparative analysis of airfoil NACA 2313 and NACA 7322 using computational fluid dynamics method.* Int. J. Sci. Prog. Res. 2015, 12, No. 4, 193-198. Available online: http://www.ijspr.com/ijspr_vol12no4.aspx (accessed on 20.10.2016).

Vadastreanu, A.M., & Gavrilă, G. (2021). *"Strategic Approaches in Aerospace Quality Management."*, Quality - Access to Success, 22(180), 75-80.

Vitalii, Y., Daniel, D., Vít, H., Václav, U., (2019). *Research of a wind tunnel parameters by means of cross-section analysis of air flow profiles*. AIP Conf. Proc. 22 November 2019; 2189 (1): 020024. https://doi.org/10.1063/1.5138636.

Waudby-Smith, P., Bender, T., Sooriyakumaran, C., Zhang, Y., Wang, H., Zhao, F., Fan, G., Sun, J., & Liu, X. (2024). *The New China Automotive Technology and Research Center Aerodynamic-Acoustic and Climatic Wind Tunnels*. WCX SAE World Congress Experience. https://doi.org/10.4271/2024-01-2541.

Wen-Chao, Y., Hui, W., Jian-Ting, Y., & Ji-Ming, Y. (2012). *Characterization of the flow separation of a variable camber airfoil*. Chin. Phys. Lett. 2012, 29, No. 4, 04470.

Wensveen, J. G. (2016). *Air transportation: A management perspective* (8th ed.). Ashgate Publishing.

Williamson, G. A. (2012). *Summary of Low-Speed Airfoil Data.* Vol. 5, Univ. of Illinois at Urbana-Champaign, Champaign, IL, 2012, Chap. 4.

Wu, Y. T., & Wu, W. H. (2008). *Integrated Design and Optimization of Aerospace Structures*. Computers & Structures, 86(1-2), 133-139.

Yang, Z., Haan, F., & Hui, H. (2007). *An experimental investigation on the flow separation on a low-Reynolds-number airfoil.* 45th AIAA Aerospace Sciences Meeting and Exhibit, Jan 8 – 11, 2007, Reno, Nevada AIAA-0275, 2007.

Zeeland, C. C. (2010). *Aviation Safety Coordinators Manual*.

Zerihan, J., & Zhang, X. (2000). *Aerodynamics of a single element wing in ground effect.* J. Aircr. 2000, 37, No. 6, 1058-1064. DOI: 10.2514/2.2711.

Zhang, W., C. W. (2015). *Geometrical effects on the airfoil flow separation and Transition*. În Computional Fluids (pg. pp 60-73).

Zhang, Y., & Yang, S. (2011). *Topology Optimization for Conceptual Design of Aircraft Wing Box Structures*. Journal of Aircraft, 48(5), 1746-1757.

Zhang, Y., Igarashi, Y., & Hu, H. (2011). *Experimental investigations on the performance degradation of a low-Reynolds-number airfoil with distributed leading edge roughness*. 49th AIAA Aerospace Sciences Meeting Including the New Horizons Forum and Aerospace Exposition, 4-7 January 2011, Orlando, Florida; AIAA: 1102, 2011.

Zhu, W., Liu, J., Sun, Z., Cao, J., Guo, G., & Shen, W. (2023). *Numerical Study on Flow and Noise Characteristics of an NACA0018 Airfoil with a Porous Trailing Edge*. Sustainability, 15, 275.