2026 ASEE ANNUAL CONFERENCE June 21–24, 2026 | Charlotte Convention Center, NC
Host Sponsor UNC Charlotte
Paper ID #51264

Design and implementation of an aerofoil flow simulation tutorial to improve students' knowledge and experience

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I am currently a Senior Lecturer in Aeronautical Engineering and the course leader for both undergraduate and postgraduate aeronautical programmes within the Department of Engineering at the University of Staffordshire, United Kingdom. Have earned aeronautical engineering-related academic & research experience from India, Malaysia & the United Arab Emirates. My main areas of research interest are aerodynamics, aircraft design, biomimetics, CFD and composites. Published various research papers in reputed journals and conferences and was recently nominated by the Royal Aeronautical Society, UK to be an aerodynamics chair at the CEAS Aerospace Europe Conference, held at Torino, Italy. Developed a new programme called Bachelor of Aeronautical Engineering Technology (Aircraft) with Honours, the first of its kind in Malaysia and developed many new modules such as aerodynamics, aircraft propulsion, aircraft design project and flight dynamics at the University of Staffordshire. Supervising many undergraduate and postgraduate research (including PhD) projects. Reviewer and editorial/technical board member at many reputed journals and conferences. Organised industry visits and numerous events such as the International Conference on Aeronautics, Astronautics and Aviation, Technical Symposiums and Guest Lectures. Delivered many invited guest lectures and talks to several educational institutions worldwide. I was honoured with the Indian Faculty Leader Award for my contribution to the aeronautical community and the Kajal Mallick Memorial Award for one of the best research publications. I am a member of many professional bodies, such as the Royal Aeronautical Society, Malaysia Board of Technologists, Institute of Aeronautics, Astronautics and Aviation, Chartered Engineer of the UK Engineering Council and Senior Fellow of Higher Education Academy.

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Dr Sheikh Islam is Head of Engineering in the School of Digital, Technology, Innovation and Business at University of Staffordshire. Dr. Islam's prior teaching leadership positions include serving as an Associate Dean, an Academic Strategic Lead (Head of Mechanical Engineering Discipline), an Academic Team Lead, and a senior lecturer for mechanical engineering courses. Dr Islam gained his PhD from Robert Gordon University in Aberdeen through research on computational fluid dynamics modelling of proton exchange membrane fuel cells. His research interests include PEM fuel cell modelling, Vertical axis wind turbine, engineering design optimisation, multi-phase flow and heat transfer analysis for industrial applications. He is a Fellow of the Higher Education Academy (FHEA). He has co-authored over 60 peer-reviewed journal articles and conference proceedings.

Mrs. Debi Marie Roberts, University of Staffordshire

Debi Marie Roberts is a Chartered Engineer and the Course Director for Engineering Distance Learning and Apprenticeships at University of Staffordshire, She brings 18 years of experience in academia and industry to her role. Prior teaching leadership positions include serving as Academic Group Leader for the Transport Engineering discipline area and a secondment to the role of Interim Head of Department (Engineering) for 12 months. She has also been Course Leader for various Aeronautical, Automotive and Motorsport courses during her time at the University. She has developed and delivered a wide variety of course curriculum modules for Transport, Construction and Mechanical Engineering areas and have twice led on the development of revitalised engineering curricula, as well as leading on the accreditation of courses by engineering professional bodies. She was part of the team at University of Staffordshire who received Office for Students Wave 1 Apprenticeship funding to develop new and innovative teaching apprenticeship courses, this was worth £974,000 across the University. She has authored articles for various journals and newspapers as well as providing engineering employability expertise to international newspapers such as the Deccan Herald. Her research areas include automation of transportation, transport history and the history of health and safety in naval dockyards. She was also part of the Boulton Paul Heritage Project, preserving aviation history and was awarded the Queen’s Award for Voluntary Service as part of the group in 2012. She is an experienced academic with a strong teaching and learning background and clear management and pedagogical experience.

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Dr Muhammad Fahad is a Senior Lecturer in Mechanical Engineering at the University of Staffordshire and Course Leader for the BEng (Hons) Mechanical Engineering programme. He holds a PhD in Mechanical Engineering from Loughborough University and brings over 20 years of academic and industrial experience in manufacturing and engineering. His expertise spans additive manufacturing, materials engineering, and lean manufacturing, with a strong focus on productivity optimisation and advanced manufacturing technologies. Dr Fahad has an extensive publication record, including journal articles and book chapters in areas such as 3D printing, materials characterisation, and manufacturing systems. He has supervised doctoral research and actively collaborates with industry on projects related to process improvement, product design, and composite materials development. His work bridges academic research and industrial application, contributing to innovation in modern manufacturing practices.

Md Asaduzzaman, University of Staffordshire

Md Asaduzzaman received the B.Sc. and M.Sc. degrees in applied statistics from the University of Dhaka, Dhaka, Bangladesh, in 1999 and 2001, respectively; the M.Sc. degree in bioinformatics from Chalmers University of Technology, Gothenburg, Sweden, in 2007; and the PhD degree in operational research from the University of Westminster, London, U.K., in 2010. He was a Lecturer and Assistant Professor of applied statistics at the Institute of Statistical Research and Training, University of Dhaka, Bangladesh, from 2001 to 2013. He is currently an Associate Professor in operational research with Staffordshire University, Stoke-on-Trent, U.K., where he has been a faculty member since 2014. He received several awards, including the first runner-up prize of ”The Doctoral Award” in 2011 from the Operational Research Society UK, and the ”Dean’s Honour Award” from the University of Dhaka in 2013 for his paper in the Journal of the Royal Statistical Society. His primary research interests include queueing and mathematical programming for performance measure, capacity and resource planning and management in healthcare and communication networks. He is also interested in statistical computing, large-scale data mining, and analysis in environmental sciences and healthcare. He was a Member of IEEE from 2016 to 2019 and a senior member of IEEE since 2019. He is currently a Fellow of the Royal Statistical Society, UK.

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Andrew Cash is a Senior Lecturer and Course Leader in Automotive and Motorsport Engineering at the University of Staffordshire. He holds a Master's in Education and is undertaking part-time doctoral research on the thermal management of lithium-ion battery systems in electric vehicles, an area of growing importance as the industry transitions towards electrification and improved energy efficiency. With 27 years' experience across Further and Higher Education, Andrew has a strong track record of developing technical capability among a wide range of learners, from apprentice technicians to undergraduate engineering students. His teaching is grounded in industry relevance, equipping students with the theoretical knowledge and practical skills needed to meet the automotive sector's evolving demands. He has played a key role in curriculum development, designing and introducing new modules with a particular emphasis on electric propulsion systems, battery technologies, and modern vehicle architectures. In addition to his teaching and research responsibilities, Andrew has actively fostered industry links. He has organised and led numerous industrial visits, providing students with valuable exposure to real-world engineering environments. Notably, he coordinated the University's first Faraday Battery Day event in 2025, bringing together students, academics, and industry professionals to engage with cutting-edge developments in battery technology. Andrew is a Fellow of the Higher Education Academy, reflecting his commitment to excellence in teaching and learning within higher education.

Saeed Shiry Ghidarry

Design and implementation of an aerofoil flow simulation tutorial to improve students' knowledge and experience

University of Staffordshire, United Kingdom.

Note to readers: The entire paper is written in British English. In the UK, module refers to a specific subject offered in the programme/course.

Abstract

Across the globe, conventional teaching methods such as lectures and in-class tutorials are widely used in engineering education. While experimental lab sessions have been included in the technical subjects, such as the wind tunnel analyses performed in most of the aeronautical engineering courses offered worldwide, these activities are still done at a very limited level. This could be due to a variety of reasons, such as model limitations, running costs, outdated or working conditions of the equipment, maintenance delays, operation restrictions (safety risks), noise issues and so on. Due to these limitations, many aeronautical academics have started to use practical tools such as ANSYS for aerodynamic, structural and propulsion related simulations in recent years. However, there is no clear evidence that these software tools can effectively improve the students' knowledge. Hence, the main aim of this research work is to prove that software simulation teaching can improve students' learning experience and knowledge. To prove this, a new aerodynamic simulation tutorial with the help of ANSYS (especially Fluent) was developed based on the NACA0015 aerofoil design. Procedures, including aerofoil design in ANSYS Discovery, computational domain development, boundary conditions set-up, mesh, solving the model in Fluent and validation are covered in this tutorial. This software simulation tutorial design was set based on Kolb's experiential learning cycle and the novel DDAMV method and is similar to the lift and drag studies conducted over an aerofoil in the wind tunnel and attains the learning outcome 2, which covers the competencies C4 and C12 AHEP4s set by the UK Engineering Council.

In terms of implementation, at first, the aerodynamic concepts such as laminar, turbulence, lift and drag forces were delivered in the lecture session and students were asked to complete a pre-tutorial questionnaire, which included questions related to their understanding level of those concepts at that stage. Then the designed tutorial sessions were delivered. In which students simulated the flow over the NACA0015 aerofoil. At the end of those sessions, they completed a post-tutorial questionnaire, which captured their thoughts and technical questions related to the simulation experience and technical knowledge. With the use of pre- and post-tutorial questionnaires and simulation result submissions, this research proved that the students can understand the aerodynamic concepts, especially the flow over an aerofoil, much better after completing the simulation tutorial. Additionally, the design simulation tutorial enhanced the students' aerodynamic knowledge and experience. This tutorial was delivered during the current academic year in the TRAN53017 module at our university. The entire research is supported by the ANSYS Curriculum Fund.

Keywords: Aerodynamics, Aerofoil Simulation, Tutorial Design, Experiential Learning

1. Introduction

Engineering teaching methods vary widely based on the context. Conventional lectures, tutorials and lab experiments are not delivered in all the modules within a course. For theoretical modules, lectures and tutorials are sufficient, mostly. In terms of subject-specific modules, such as aerodynamics, practical sessions are equally important as lectures and tutorials. Since Covid, there has been a drastic surge in the use of computational tools to complement and in some cases, replace lab experiments. This is due to a number of reasons as stated in the abstract. For example, the need for engineering students to get equipped with modern computational skills for solving complex problems [1]. However, recent works [2,3] on computational aerodynamics teachings have proven that although there is a need, it is essential that learning outcomes be designed in a simulation tutorial and matched with the corresponding module, so that the academics can measure and verify whether students have achieved the required level of competence through these simulation tutorials or not, as per the standards set by the professional bodies. For example, every undergraduate engineering student must gain 18 AHEP4 (The Accreditation of Higher Education Programmes, Fourth Edition) competences set by the UK Engineering council before they graduate the course.

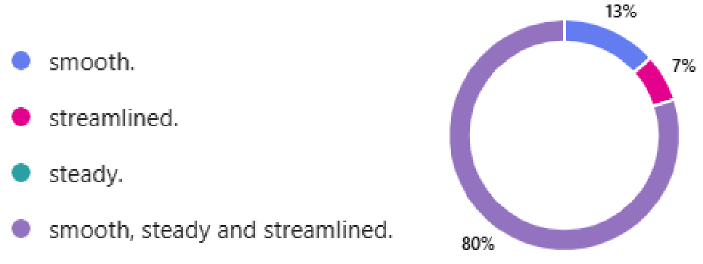
2. Learning Outcome

At level 5 (which means the second year) of an undergraduate engineering course, students are expected to attain practical skills in their core modules. Out of the 18 AHEP4s set by the UK Engineering Council, two competences, such as, C4 and C12, are related to technical literature and practical skills [4], respectively. Therefore, to deliver and assess these competences, a second learning outcome (LO2) was developed – 'calibrate a subsonic wind tunnel and investigate the aerodynamic forces in it', in the new core module named TRAN53017-Aerodynamics and Propulsion, using Bloom's Taxonomy [5]. This LO2 aligns with the analysis and problem-solving outcomes of the programme. There are 3 learning outcomes in the TRAN53017 module. Other learning outcomes, i.e. LO1 & LO3, are not related to the aerodynamic practical skills and hence, not covered in this tutorial.

3. Need for a Simulation Tutorial (at our University)

To achieve the LO2, students analysed the airflow over a streamlined body in a wind tunnel test section and measured its aerodynamic forces. This lab session was delivered a week after a lecture on basic aerodynamic concepts such as lift, drag, laminar and turbulence. During the lab sessions, a number of limitations (such as flow speed range, minor variations in measurements from one group to another – quite common in experimental works, model types and so on) were observed. Although students gained the essential knowledge and skills to investigate the aerodynamic surfaces (as they did the experiments on their own after an initial demonstration), the above-mentioned observations hindered the in-depth practical learning of aerodynamics. The level of their understanding was captured using a pre-tutorial questionnaire, which was submitted by the students anonymously after the lab sessions. From this submission, it was identified very clearly that students were able to answer the basic questions well but not the in-depth technical questions. For example, 80% of students answered that a laminar flow is smooth, steady and streamlined, but only 60% of students responded that lift gets generated when pressure is low at the top and high at the bottom surfaces of an aerofoil. These results are shown in Figure 1, below. Hence, to widen their knowledge and improve learning experience, a computational simulation tutorial was carefully developed to meet the module's learning outcome and delivered.

A laminar flow is _________.



How does lift get generated on an aerofoil?

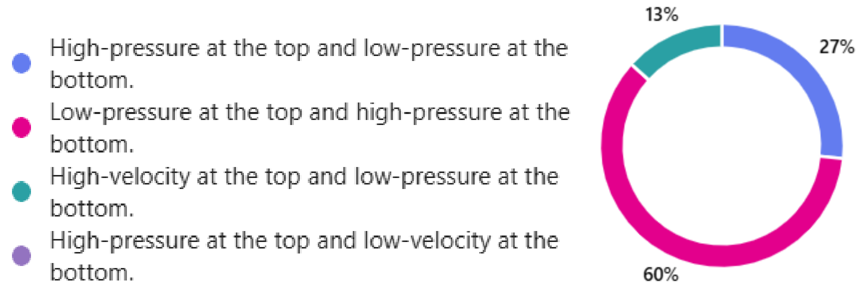


Figure 1. Pre-Tutorial Responses (Examples) – Laminar flow related question (top) and Lift related question (bottom)

4. Pedagogical Approach

The aerodynamic simulation tutorial, which covers the LO2, was designed using Kolb's experiential learning cycle [6], as shown in Figure 2. As Kolb described, learning is a cyclic process and it involves four stages. They are as follows.

- Concrete experience – airflow investigations conducted using a wind tunnel proved the importance of streamlined bodies, which were informed during the lecture sessions.
- Reflective observation – the knowledge levels related to the experimental airflow investigations were reviewed using a pre-tutorial questionnaire.
- Abstract conceptualisation – after analysing the answers provided by students for the technical questions asked in the pre-tutorial questionnaire, it was determined that they have gained the basic level of knowledge and skills but require more support to improve their in-depth understanding of airflow investigations.
- Active experimentation – a new airflow simulation tutorial was developed using ANSYS Fluent to improve the students' knowledge and learning experience. Their knowledge levels and experience were captured with the help of a post-tutorial questionnaire.

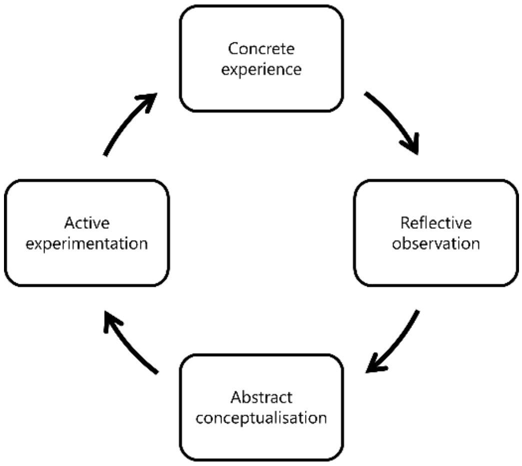


Figure 2. Kolb's Experiential Learning Cycle [6]

5. Tutorial Design

Based on the findings from the pre-tutorial questionnaire and using Kolb's cycle, a novel procedure is developed to design the aerodynamic simulation tutorial. The abbreviation of this method is DDAMV (Define, Design, Analyse, Measure, Validate) inspired by the Design for six sigma framework (Dfss) [7]. The commonly used Dfss technique is DMADV – Define, Measure, Analyse, Design, Validate. This is modified to DDAMV as the aerofoil needs to be designed and analysed first in order to measure the aerodynamic coefficients.

5.1. **D**DAMV - Define

Based on the level of the students and available resources, it was decided to perform two-dimensional (2D) aerodynamic analysis over the NACA0015 aerofoil at a 7-degree angle of attack (AoA) using the ANSYS Fluent software [8]. NACA0015 was selected to introduce as many models as possible to the students, apart from the model used for wind tunnel analysis earlier. This tutorial was expected to offer an in-depth understanding in terms of airflow interactions, lift and drag generation, pressure and velocity distributions.

5.2. D**D**AMV - Design

To ease the design procedure for students, it was decided to place the aerofoil in a horizontal position. The coordinates [9] of NACA0015 aerofoil with 1metre (m) chord length were imported into the ANSYS Design modeller. A C-type computational domain of 10 times the chord length was designed around the aerofoil and then these were converted into a surface. Finally, the aerofoil surface was removed from the design as this would be a fluid analysis (which is explained in the next section 5.3.). The final design is shown in Figure 3.

5.3. DD**A**MV - Analyse

In the ANSYS Mesh tool, the 2D design was imported, and a default mesh was generated and that was coarse. To refine the mesh, a sphere of influence mesh was generated with an element size of 0.05m from the centre of the aerofoil with a radius of 2.5m. An edge sizing was then applied to the aerofoil curvature. Finally, boundary conditions such as inlet, outlet and aerofoil were defined. The meshed design is shown in Figure 3. The meshed design was then checked for errors in the Fluent Setup tool. The inviscid model was chosen as the flow speed and density assumed were 1 m/s and 1 kg/m^3, respectively. These values were decided for teaching purposes and to easily match the theoretical values. Based on the flow speed, the X and Y velocities were mentioned within the velocity-inlet. All the other values were set as default, computed from an inlet and performed hybrid initialisation, which set the initial values and iteration was done. As the aerofoil was kept in a horizontal position, the airflow would approach the model at the assumed 7-degree AoA. The converged solution was captured in the lift iteration plot as shown in Figure 3.

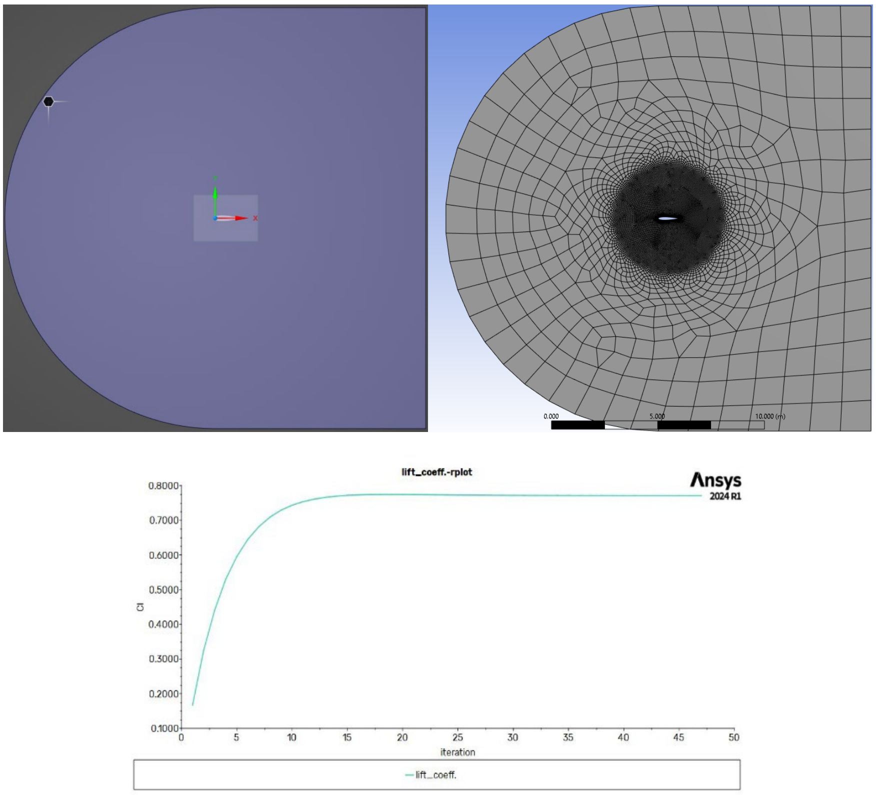


Figure 3. 2D NACA0015 – Design (left), Mesh (right), Lift-Iteration (bottom)

5.4. DDA**M**V – Measure

Using the Fluent Solution tool, the lift and drag coefficients were printed on the console. Then the pressure contour and velocity vectors were exported as shown in Figure 4. Static pressure contour clearly visualised the low and high pressure distributions at the top and bottom surfaces, respectively. Additionally, stagnation pressure was identified near the leading edge where the velocity is almost zero, which was verified with the help of velocity vectors shown in Figure 4. Higher values of velocities were observed around the top surface of the NACA0015 aerofoil, which evidenced good lift generation for the given conditions.

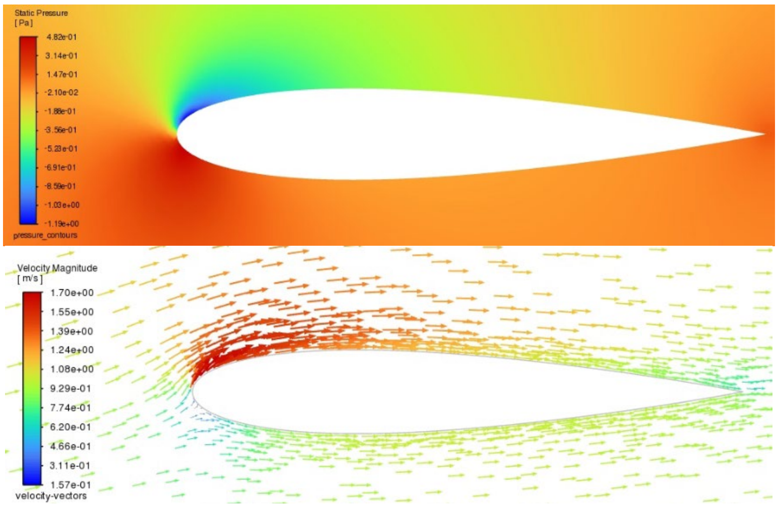


Figure 4. Static Pressure Contour (top) and Velocity Vectors (bottom)

5.5. DDAM**V** - Validate

To validate the results obtained, theoretical calculations were done to find the lift and drag coefficients for the NACA0015 in inviscid and incompressible flow using the thin aerofoil theory [10].

(i) Lift coefficient = $2\pi\alpha$ (note: π-3.14, α – 7^0AoA) = 0.77.
(ii) Drag coefficient = zero, because the flow is inviscid (1 metre/second).

In Table 1, the theoretical and simulation results were compared, and it was noted that lift coefficients matched exactly. Drag was zero, theoretically, and the same or closer value was obtained in the simulation when 0.015 was rounded off. These comparisons proved that the research method used was reliable, and the results obtained were appropriate.

Coefficients	**Theoretical Values**	**Fluent Results**
Lift	0.77	0.77
Drag	0	0.015 (close to 0)

Table 1. Validation

6. Tutorial Delivery

The entire computational aerodynamics tutorial was delivered in three parts to avoid overloading the students.

- Session 1 - In this first part of the tutorial, theoretical calculations were done for the NACA0015 aerofoil. Then, the 2D design of the NACA0015 aerofoil and C-computational domain were created using ANSYS Discovery.
- Session 2 - In this second part of the tutorial, the 2D design was meshed in the ANSYS Mesh. Then, the meshed design was analysed in the Fluent Setup.

- Session 3 - In this last part of the tutorial, solutions such as plot and graphics were analysed. Then, the results obtained were compared against the theoretical values.

7. Post-Tutorial Analysis

The technical questions asked in both the pre-and post-tutorial questionnaires were not the same, but the areas focused were the same, such as laminar flow, turbulent flow, lift and drag generation. However, the self-evaluation related questions were the same to understand how they feel about themselves at different stages. Based on Table 2, it is clear that after the simulation tutorial they felt more confidence as it improved their knowledge levels in the range 3.89 to 16.94 %.

Self-Evaluation - What is your level of understanding about…	**Level of Understanding (1, poor - 10, excellent)**		**Improvement**
	Pre-Tutorial (average)	**Post-Tutorial (average)**	
Laminar flows	6.93	7.2	3.89 %
Turbulent flows	6.47	7.2	11.28 %
Lift	6.67	7.8	16.94 %
Drag	6.73	7	4.01 %

Table 2. Level of Understanding: Pre Vs Post Tutorial

These evaluations corroborate with the technical answers provided in the post-tutorial questionnaire. For example, all the students answered that a symmetrical aerofoil would not generate a larger amount of drag at zero AoA. 80% of the students responded that turbulent flow is neither smooth and nor regular but unsteady. These are shown in Figure 5.

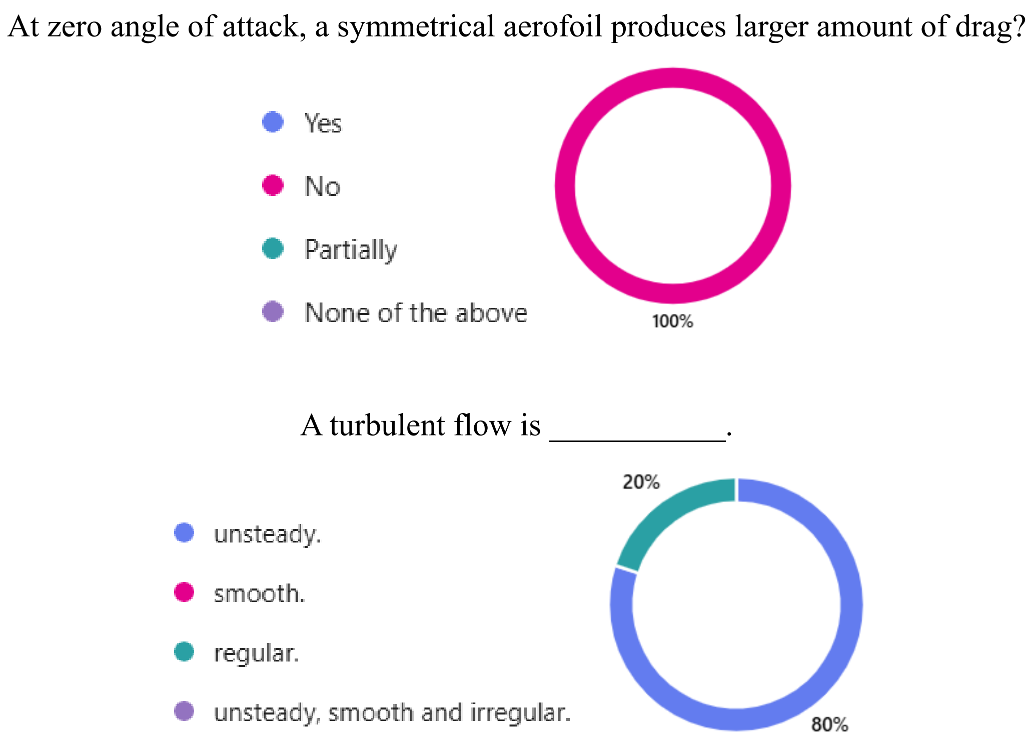


Figure 5. Post-Tutorial Responses (Examples) - Drag related question (top) and Turbulent flow related question (bottom)

8. How has the learning environment improved?

   Compared to lectures and tutorials, students' interactions increased drastically in the simulation tutorial sessions. For example, they made a few mistakes, such as clicking the wrong tools in the software, not deleting the aerofoil after separating the surfaces, using incorrect dimensions/units, failing to create a new aerofoil centre in the global coordinate system, saving the files in the cloud appropriately, and so on, individually. These are considered as productive failures in the tutorial learning environment. To fix these mistakes, they interacted with their peers and the academic staff very often in each simulation tutorial session. At least 2 questions were raised by each student in every tutorial session. At the end, this tutorial showed a massive improvement in terms of student-staff communication, interaction with peers (also known as collaborative learning) and raising questions without hesitation (related to psychological safety). According to Vygotsky's Social Constructivism theory [11], this tutorial acted as a mediating tool between staff and students and changed the academic from lecturer to facilitator. The learning culture has become more vibrant and this was reflected in their attendance at these sessions, which was an average of 82% overall. This tutorial moved the learning environment to interactive, constructive and active from passive lectures, which is a proof of the ICAP framework [12]. ICAP means Interactive, Constructive, Active and Passive. This hypothesis suggests that to increase the students' engagement and learning, it is essential to move them from passive to active to constructive to interactive environment.

9. Learning Outcome Attainment

   At the end of the tutorial, students submit their results, in addition to the above-discussed post-tutorial questionnaire. A sample submission is shown in Figure 6. Their results captured the same lift and drag values, which proved that they learnt the practical skills well by analysing the NACA0015 aerofoil model, computationally. They completed this simulation tutorial by reviewing the provided technical literature (handout, reports & so on) and learning the practical skills such as design, mesh, solver, theoretical calculations, plots and graphics reviews and so on. Thus, achieving the AHEP4 competences C4 and C12 through their result submissions. However, it was decided that this tutorial would not fully replace the wind tunnel sessions but effectively complement that by filling the gaps that were left during the lab experiments and hence, not proposed as an assessment element yet. In the future, both computational and experimental sessions' outputs will be included in the assessments.

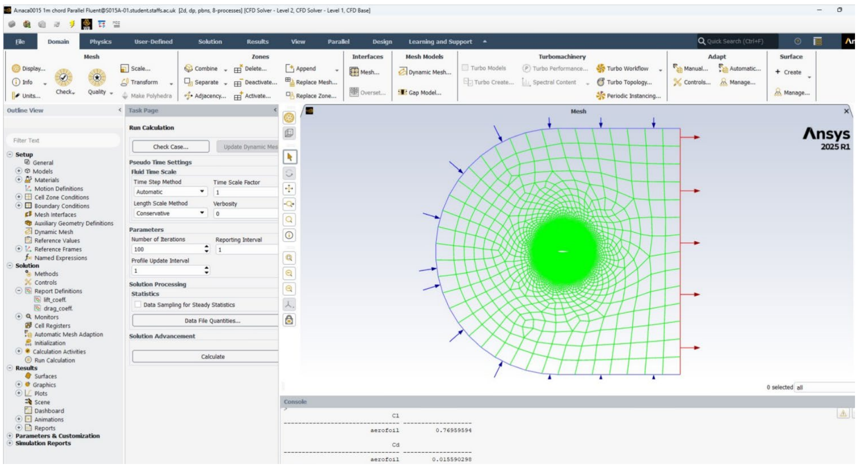


Figure 6. Student Submission Sample – Lift and Drag Values Printed in Console

10. Was this tutorial inclusive?

This tutorial introduced alternative learning tools to students of all backgrounds. It was clearly stated that this tutorial is voluntary. Although this was optional for everyone, students identifying as Black (6.7%), South Asian (26.7%) and White (66.6%) have actively participated in this tutorial, as shown in Figure 7. This means 100% of minority (Black/South Asian) students in the level 5 (second year) aeronautical cohort have participated in this tutorial. Out of 17 students enrolled in the module, 14 students voluntarily participated in this aerofoil flow simulation tutorial. This was the first time they had used the ANSYS software. To support a variety of learning needs, three videos were created and shared with them, in addition to the handouts. Splitting the tutorial into three parts helped the students to understand the steps clearly. These efforts were made available to allow equal participation from students of diverse backgrounds.

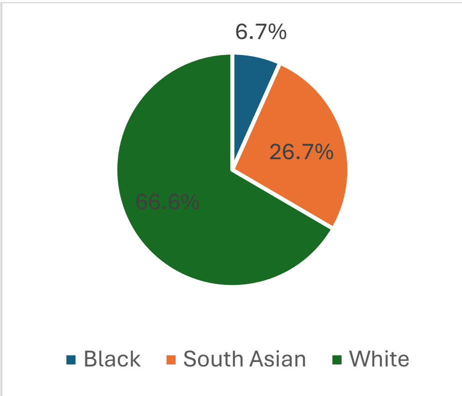


Figure 7. Background of Participants

11. Experimental Analysis Vs Computational Simulation

In the normal wind tunnel lab session delivered at undergraduate level, lift and drag analysis over an aerofoil was focused on experimental set up (including model, flow conditions and so on), obtaining results, comparing against the expected/theoretical results, observing errors, repeating the measurements if required and plotting the values. Elements such as calculations, errors and discussions on results were asked to be included in the report later. Although the source of error was discussed, uncertainty quantification and statistical analysis were not performed as these are not required to be covered at this stage and not possible to cover in a single session. Also, these are covered in different modules.

All the elements (except for hands-on equipment training/experience) covered in the wind tunnel experiment were also covered in ANSYS simulations as mentioned below.

- Experimental set up – model and computational domain development, meshing, defining boundary conditions, flow properties, solution method and so on.
- Obtaining results – setting the criteria and printing results in the console
- Comparison – checking the results obtained against the theoretical values
- Observing errors – observing the residuals, iteration plots, convergence criteria and results for errors

- Repeating the measurements if required – students had repeated the procedure due to productive failures discussed in section 8
- Plots – analysing lift and drag plots and velocity & pressure pathlines/contours

In addition to the above, more elements were covered in the ANSYS simulation when compared to the normal wind tunnel session. Based on the observations from the ANSYS tutorial and wind tunnel sessions, the following factors are analysed in Table 3.

Factors	Wind Tunnel Experiment	ANSYS Tutorial
Communication	Due to operational noise, communication was less and harder	Student-staff interaction increased
Model scope	Limited to the test section size	No limit on the shape/size but decided to make a 2D design for teaching purposes
Flow speed range	Maximum speed is 30 m/s	No restriction but decided to perform inviscid flow analysis
Flow visualisation	Hard to observe as it is not equipped with a smoke generator	Better due to the use of plots, graphics (contours, vectors, pathlines, pulse animations)
Results	Not consistent. Every student group obtained minor variation in results	All the students obtained the same results
Learning outcome	Basic level achieved but students struggled with in-depth technical questions	In-depth technical level improved

Table 3. Factors: Wind Tunnel Experiment Vs ANSYS Tutorial

12. Conclusion

In addition to the videos created for each part of the delivery, a handout was shared with all students for the entire tutorial. This helped them refer to the material and sort out the issues quickly. Overall, 100% of the students responded that they fully understood the aerodynamic concepts in the simulation tutorial when compared to 53% fully and 47% partially in the lecture session. Similarly, 60% of students responded that their knowledge improved in the simulation tutorial session when compared to wind tunnel sessions, which is proof of improvement in terms of the learning environment. Apart from these indicators, it was very clear from their answers (Figures 1 and 5) to the technical questions that their knowledge improved a lot after attending the NACA0015 simulation tutorial sessions. Over 82% of attendance shows strong engagement for voluntary sessions. This tutorial was a platform for the students to experience a range of elements, such as collaborative learning, psychological safety, active experiential learning, interactive learning and so on. In addition to improving the students' knowledge and experience and covering the learning outcome, this tutorial has also demonstrated to them 'how to conduct research work using computational tools' with the help of the novel DDAMV method. Although the current simulation set up is specific to the aerofoil used, the DDAMV method can be used for any aerofoil and inlet airspeed. Thus, it proves that the simulation tutorials, if designed and delivered with an appropriate methodology, can complement or even replace experimental sessions. Choosing computational analysis over an experimental method may reduce the hands-on equipment experience. This can be avoided by performing analysis in both ways, like a hybrid approach. Also, based on the wind tunnel type and manufacturer requirements, the experimental procedure varies.

Ethics Information: The University of Staffordshire Ethics Committee's approval was obtained for this work.

Acknowledgement: The entire research is funded by the ANSYS Curriculum Fund.

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