

**AERODYNAMICS BEHAVIOUR OF PERSONA CAR USING
COMPUTATIONAL FLUID DYNAMICS (CFD)**

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USING COMPUTATIONAL FLUID DYNAMICS (CFD)**
SESI PENGAJIAN: **2009/ 2010**

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Examiner

.....

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AERODYNAMICS BEHAVIOUR OF PERSONA CAR USING COMPUTATIONAL
FLUID DYNAMICS (CFD)

MOHD SHAIFULLAH BIN SHAHRUDDIN

Report submitted in fulfilment of the requirements
for the award of the degree of
Bachelor of Mechanical Engineering with Automotive Engineering

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I hereby declare that the work in this project is my own except for quotations and summaries which have been duly acknowledged. The project has not been accepted for any degree and is not concurrently submitted for award of other degree.

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To my beloved father mother

Shahrudin bin Ahmad

Mohaini binti Yahya

ACKNOWLEDGEMENTS

First of all, I want to thank The Almighty Allah SWT for the beautiful life that has been given to me in the past 22 years and the present. I am very thankful to be given the time and chances to finally complete this research. I am grateful and would like to express my sincere gratitude to my supervisor Mr. Muhamad Zuhairi Sulaiman for his brilliant ideas, invaluable guidance, continuous encouragement and constant support in making this research possible. He has always impressed me with his outstanding professional conduct, his strong conviction for science, and his belief that a Bachelor program is only a start of a life-long learning experience. I appreciate his consistent support from the first day I applied to PSM course to these concluding moments. I am truly grateful for his progressive vision about my work progressing, his tolerance of my naive mistakes, and his commitment to my future career. I also would like to express very special thanks again to my supervisor for his suggestions and co-operation throughout the study. I also sincerely thanks for the time spent proofreading and correcting my many mistakes.

I also would like to express my gratitude to the Faculty of Mechanical Engineering and Universiti Malaysia Pahang, for their assistance in supplying the relevant literatures.

I am also obliged to express my appreciation towards my beloved mom and dad and also my family members for their enduring patience, moral and financial supports. My fellow friends should also be recognised for their support. My sincere appreciation also extends to all my colleagues and others who have provided assistance at various occasions. Their views and tips are useful indeed. Unfortunately, it is not possible to list all of them in this limited space. Thank you to all. Thank you for everything. May God bless all of you.

ABSTRACT

An aerodynamic characteristic of a car is of significant interest in reducing car accidents due to wind loading and in reducing the fuel consumption. On the limitations of conventional wind tunnel experiment and rapid developments in computer hardware, considerable efforts have been invested in the last decade to study vehicle aerodynamics computationally. This report presents a numerical simulation of flow around Proton Persona car using commercial fluid dynamics software FLUENT for 2D simulation and COSMOSFloWorks for 3D simulation. The study focuses on CFD-based lift and drag coefficient prediction on the car body and the air flow pattern around the car body using Computational Fluid Dynamics (CFD) software. A three dimensional computer model of a Proton Persona was used as the base model in this study. The wind speed selected in this study ranges from 80 km/hr to 140 km/hr with increment of 20 km/hr. After numerical iterations are completed, the aerodynamic data and detailed complicated flow behaviour are visualized clearly. The drag and lift coefficient of Proton Persona have been estimated by using a mathematical equations. The pressure and velocity distributions along the surface of the car also have been analyzed. From the results obtained, it was found that highest speed occurs where the pressure is lowest, and the lowest speed occurs where the pressure is highest. Therefore it satisfies the Bernoulli's principle. In addition, the flow pattern around the model showed very similar with the previous works, emphasizing in findings.

ABSTRAK

Ciri aerodinamik sesebuah kereta adalah sangat penting dalam pengurangan kadar kemalangan kereta yang disebabkan oleh beban angin dan dalam mengurangkan penggunaan minyak. Oleh sebab terdapat had-had bagi eksperimen terowong angin konvensional dan pembangunan pantas dalam perkakasan komputer, ikhtiar yang banyak telah dilaburkan dalam dekad yang lalu untuk mengkaji aerodinamik kenderaan secara pengkomputeran. Laporan ini membentangkan satu penyerupaan berangka aliran sekitar kereta Proton Persona menggunakan perisian komersial dinamik bendalir *FLUENT* untuk simulasi 2D dan *COSMOSFloWorks* untuk simulasi 3D. Kajian itu menumpukan pada ramalan pekali daya angkat dan seretan pada badan kereta dan corak aliran udara sekitar badan kereta itu menggunakan perisian *Computational Fluid Dynamics (CFD)*. Satu model komputer tiga dimensi, Proton Persona telah digunakan sebagai model asas dalam kajian ini. Kelajuan angin yang pilih dalam julat kajian ini adalah daripada 80 km/jam hingga 140 km/jam dengan tambahan setiap 20 km/jam. Selepas iterasi berangka siap, data aerodinamik dan sifat aliran rumit yang terperinci dipaparkan dengan jelas. Pekali seretan dan daya angkat Proton Persona telah dianggarkan dengan menggunakan persamaan matematik. Pengagihan tekanan dan halaju sepanjang permukaan kereta itu juga telah dianalisis. Daripada keputusan yang diperolehi, didapati kelajuan tertinggi itu berlaku di mana tekanan terendah, dan kelajuan terendah berlaku di mana tekanan tertinggi. Oleh itu ia memuaskan prinsip Bernoulli. Seperkara lagi, corak aliran sekitar model itu menyerupai dengan kajian terdahulu, mengukuhkan lagi penemuan.

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LIST OF SYMBOLS

| | |
|---------------|--|
| A | Area |
| C_D | Drag Coefficient |
| C_L | Lift Coefficient |
| p | Pressure |
| ρ | Density |
| v | Velocity |
| F_D | Drag Force |
| F_L | Lift Force |
| μ | Dynamic Viscosity |
| C_p | Pressure Coefficient |
| p_∞ | Initial Pressure |
| v_∞ | Initial Velocity |
| k | Turbulence kinetic energy |
| ε | Kinetic energy dissipation rate |
| τ_{ij} | Shear-stress tensor |
| S_{ij} | Shearing-rate tensor |
| σ_k | Prandtl number of the turbulence kinetic energy |
| | Prandtl number of the turbulence kinetic energy dissipation rate |

LIST OF ABBREVIATIONS

| | |
|-------|----------------------------------|
| 2-D | Two Dimensional |
| 3-D | Three Dimensional |
| CAD | Computational Aided Design |
| CFD | Computational Fluid Dynamics |
| DNS | Direct numerical simulation |
| DSM | Differential stress models |
| EVM | Eddy-viscosity models |
| FYP | Final year project |
| LES | Large-eddy simulation |
| NLEVM | Non-linear eddy-viscosity models |
| RANS | Reynolds-Averaged Navier-Stokes |
| Re | Reynold Number |
| RNG | Renormalization Group |
| RSTM | Reynolds-stress transport models |
| SOC | Second-order closure models |