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Research Proposal & Presentation

Aerodynamic Validation and Upgrade Assessment of the MCR-S2N/S2N+ Airbox
Package within the Wider Vehicle Package Context

Research Methods (ACHA7027)

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2. Abstract

This proposal outlines a validation-led investigation into the aerodynamic behaviour of the MCR-S2N/S2N+ airbox package within the Sports 2000 Duratec category. The study addresses the lack of detailed validation of the upgraded package, particularly in relation to externally exposed inlet conditions, steady internal airflow, and selected transient intake effects. The methodology combines external and internal CFD with flow-bench data, pressure measurements, dynamometer evidence, and existing wind-tunnel, track, and consultancy CFD datasets where available. The project is expected to clarify whether differences between S2N and S2N+ are driven primarily by the airbox, the wider package, or interaction between the two, and to support justified engineering decisions within a regulation-constrained design space.

3. List of Abbreviations

Abbreviation	Meaning
CAD	Computer-Aided Design
CFD	Computational Fluid Dynamics
MCR	MCR Race Cars
MIRA	Motor Industry Research Association
S2N	Sports 2000 New
S2N+	Sports 2000 New +
S2NUW	Sports 2000 New University of Wales

4. Introduction

4.1 Background

In race-car applications, the airbox is not merely an intake component for supplying air to the engine. Its geometry can affect pressure recovery, internal flow losses, and the quality of airflow delivered to the engine, making it a performance-critical part of the intake system (Muckova, et al., 2023; De Vita, et al., 2001). Changes in intake and plenum geometry can also influence cylinder-to-cylinder flow behaviour and volumetric efficiency trends, indicating that airbox design has consequences beyond simple packaging (Muckova, et al., 2023; Shin, et al., 2022).

Within the MCR Sports 2000 platform, the S2N and S2N+ represent different stages of package development. The present study focuses on the airbox package, particularly the S2N+ configuration, while recognising that surrounding package changes may also alter the flow reaching the inlet. The airbox must therefore be studied not only as an internal flow device, but as a component operating within a wider vehicle-level context.

Because the MCR package operates within the Sports 2000 Duratec ruleset, the study is concerned not only with aerodynamic performance, but also with what can be validated and potentially improved within a regulation-constrained design space.

4.2 Problem Statement

At present, the aerodynamic behaviour of the airbox package has not been fully validated in either internal or external terms. Internally, there is uncertainty regarding pressure loss, flow quality, distribution, and the possible influence of plenum volume. Externally, there is uncertainty regarding inlet conditions, ram-air effects, and the extent to which surrounding aerodynamic features influence the package. As a result, the true performance of the current configuration is not yet fully understood.

A further challenge is that the S2N and S2N+ differ by more than the airbox alone. Other aerodynamic changes may also influence whole-car behaviour, meaning that any overall difference between the two package states cannot automatically be attributed to the airbox itself. A structured validation approach is therefore required to assess the package while separating, as far as practical, airbox-specific effects from wider package-level changes.

4.3 Research Rationale

This research adopts a validation-led approach to assess the MCR airbox package within its vehicle-level environment. It examines internal airflow, external airflow, and selected transient intake effects to determine how the package performs and whether CFD can represent that behaviour reliably. This is important because validation literature shows that intake geometry, flow distribution, and resonance-related behaviour can affect performance, while numerical predictions gain value

only when they are checked against experimental evidence (Shin, et al., 2022; Muckova, et al., 2023; Brennan, et al., 2007).

The study is significant in both practical and academic terms. Practically, it may support better engineering judgement by clarifying whether the current package performs as intended and whether further design changes are justified. Academically, it addresses a focused motorsport engineering problem by investigating how internal airflow, external conditions, and transient intake behaviour interact within a changing package context.

5. Aim, Objectives and Research Questions

5.1 Aim

The aim of this research is to investigate and validate the aerodynamic behaviour of the MCR-S2N/S2N+ airbox package within the wider vehicle package context, and to assess whether design differences can be understood and justified through a combination of CFD and available validation data.

5.2 Objectives

- To define the S2N and S2N+ study configurations and relevant package context.
- To assess steady internal airflow, including pressure loss, flow quality, and flow distribution.
- To investigate selected transient intake effects, including plenum volume and resonance-related behaviour, using CFD and supporting dynamometer data where available.
- To evaluate the wider aerodynamic context affecting inlet performance, including external flow conditions, ram-air effects, and interaction with surrounding package features.
- To compare CFD results with available validation data, including flow-bench, pressure, dynamometer, and relevant legacy datasets where possible.
- To use controlled comparison methods, where practical, to distinguish airbox-specific effects from wider package-level changes and assess whether further design improvement is justified.

5.3 Research Questions

- How does the MCR-S2N/S2N+ airbox package behave in steady internal airflow terms, particularly with respect to pressure loss, flow quality, and flow distribution?
- To what extent do transient intake effects, including plenum-volume-related and resonance-related behaviour, influence the performance of the package?

- How do external flow conditions and surrounding aerodynamic features affect inlet behaviour and the wider aerodynamic performance of the airbox package?
- How reliably can CFD predict the behaviour of the airbox package when compared with available experimental and legacy validation data?
- To what extent can observed performance differences between S2N and S2N+ be attributed to the airbox itself rather than to wider package-level changes?
- Based on the validation results, is further design development of the airbox package justified?

6. Literature Review

6.1 Internal Airflow in Airbox Systems

The internal aerodynamic behaviour of an airbox system is performance-critical because it influences more than the total mass of air supplied to the engine. Internal geometry affects pressure loss, pressure recovery, local separation, and the quality of downstream flow delivered to the intake system. In racing applications, this means the airbox should not be treated as a passive enclosure, but as an active flow-management component whose geometry can influence engine breathing and intake efficiency (De Vita, et al., 2001), showing that computational and experimental analysis could be used to optimise intake airflow rather than treating the airbox as a simple packaging constraint.

A key theme in the SAE literature is that internal intake development is not a single-metric problem (Tallio, et al., 1993), showing that intake-system losses are not uniformly distributed and that certain regions can dominate the total penalty. Their work demonstrated that reducing steady-flow losses could improve peak performance while introducing trade-offs elsewhere in the operating range. This suggests that internal airbox assessment should not be reduced to headline flow rate alone. Pressure loss matters, but so do distribution quality, operating sensitivity, and the location of the losses within the system.

That broader view is reinforced by (Claywell, et al., 2006), who considered cylinder-to-cylinder volumetric-efficiency variation, total pressure loss, and broader system behaviour in their Formula SAE intake investigation. For a multi-cylinder racing engine, a design that improves average flow but worsens distribution may still be undesirable. Internal airbox development therefore needs to be judged in terms of comparative behaviour rather than simple geometric change.

The literature also supports a validation-led methodology (Muckova, et al., 2023), showing that CFD-based airbox optimisation can be strengthened through flow-bench comparison, with the optimised geometry improving cylinder filling uniformity and the experimental results supporting the numerical predictions. The internal-flow literature therefore justifies focusing the present study on pressure loss, flow quality,

and configuration-to-configuration comparison as the core metrics of airbox assessment.

Although these studies support CFD-led intake assessment, much of the evidence is based on engine-intake optimisation in controlled conditions rather than on an externally exposed race-car intake operating within a wider aerodynamic package. Several studies are also more focused on internal loss management than on the transferability of results once the inlet condition is shaped by vehicle-level flow. This limits direct transfer to the present project and supports the need for a combined internal–external validation approach rather than an isolated internal duct study.

6.2 External Flow, Inlet Conditions, Ram-Air Effect and Aero Interaction

For an externally exposed intake, performance depends not only on the internal geometry of the airbox, but also on the quality of the external flow presented to the inlet. The intake opening therefore cannot be treated as a neutral boundary condition. Its behaviour depends on the local pressure field around the vehicle, the direction and stability of the approaching flow, and the extent to which surrounding bodywork preserves or degrades useful total pressure at the intake entrance. Airbox performance therefore cannot be understood fully from internal-flow analysis alone.

A key implication is that inlet position is not aerodynamically neutral (Upadhyaya, et al., 2024), showing that changing intake position relative to the front-end flow field altered not only drag, but also the local aerodynamic behaviour of surrounding surfaces, including the wheel region. Although their study examined a simplified road-vehicle case rather than a race-car airbox, it remains relevant because it demonstrates that an inlet interacts with the wider external flow environment rather than simply receiving undisturbed freestream air. This supports the need to assess whether the S2N and S2N+ package states alter the flow reaching the exposed intake through changes in nearby bodywork, wake structure, or local pressure recovery.

The literature also suggests that any ram-air benefit should be treated critically rather than assumed. A forward-facing or externally exposed intake may offer access to a higher-pressure region, but its value depends on whether the inlet operates in a favourable part of the flow field and whether the package can convert that condition into a useful intake benefit (Khatri, et al., 2001), because exposed intake arrangements may still introduce practical trade-offs when directly exposed to the external environment.

This wider vehicle-level perspective also supports the need for aerodynamic correlation across both external and internal automotive flows (Williams & Shires, 2002). The exposed airbox inlet should therefore be assessed as part of a coupled flow system in which local pressure distribution, nearby aerodynamic features, and wider package changes affect the conditions presented to the intake. The literature therefore justifies treating inlet conditions, ram-air potential, and aero interaction as necessary parts of airbox validation.

The external-flow literature is relevant, but not fully equivalent to the present problem. Some studies use simplified road-vehicle analogues or cooling-intake cases rather than regulation-constrained race-car intake arrangements, which limits direct transferability. For the present project, these studies are most useful as aerodynamic analogues rather than exact precedents, which strengthens the case for combining package-level CFD with intake-specific validation.

6.3 CFD Validation and Modelling Considerations

CFD is valuable in motorsport development because it can resolve local flow structures, compare multiple configurations efficiently, and provide aerodynamic insight that would be difficult to obtain from physical testing alone. However, the literature does not support treating CFD as self-validating (Williams & Shires, 2002), framing validation as a necessary part of racing-car analysis and design rather than as an optional check after modelling. That position is directly relevant to the present study, since the airbox package involves both internal and external flow behaviour, meaning that confidence in the numerical model depends on correlation with physical or legacy evidence rather than on numerical output alone.

A consistent theme in the literature is that model reliability depends on the overall CFD methodology rather than on software choice alone. Geometry quality, computational domain, mesh strategy, wall treatment, turbulence modelling, and boundary-condition definition all influence the aerodynamic solution. (Doddegowda, et al., 2006) are useful here because they show that relatively accessible CFD methods can support Formula SAE aerodynamic development, but only when the results are checked against wind-tunnel testing.

This issue is closely linked to modelling simplification (Desai, et al., 2008), showing that comparative CFD can remain useful in motorsport applications, including wings and underbody cases, provided that its assumptions are understood and interpreted within an appropriate validation framework. The implication is not that simplified CFD is invalid, but that its intended use must be explicit. A lower-complexity model may still be useful for comparative judgement if its limitations are acknowledged and its predictions are tested against suitable reference data.

Supporting literature outside the technical-paper literature sharpens this discussion. (Sahini, 2004) is useful because wind-tunnel confinement and blockage can alter measured aerodynamic behaviour relative to open-road conditions, which matters whenever CFD and physical data are compared. (McBeath, 2015) is also helpful because it reinforces the importance of separation behaviour, boundary-layer control, and aerodynamic trade-offs when interpreting CFD outputs in race-car applications.

This broader validation perspective is reinforced again by (Brzustowicz, et al., 2002), whose work on aerodynamic development of the Dodge Intrepid R/T race car illustrates a closed-loop process in which CFD, scale-model work, and full-scale correlation were used together to increase confidence in the results. The literature

therefore justifies using CFD extensively in the project, but only where modelling assumptions, validation basis, and intended confidence level are made explicit.

A further limitation in the CFD literature is that different studies adopt different balances between fidelity and practicality, ranging from highly simplified comparative models to more heavily validated workflows. For the present project, a validation-led CFD-centred method is preferred over purely isolated CFD or purely experimental testing because it provides a practical route to assess both package interaction and intake behaviour while remaining feasible within the available time and data constraints.

6.4 Plenum Volume, Intake Resonance and Transient Intake Behaviour

Plenum volume and intake resonance are relevant because intake systems do not operate only under steady-flow conditions. Pressure-wave activity generated by valve events means that airbox behaviour is influenced by transient as well as steady effects. Changes in airbox volume may therefore alter not only restriction and flow distribution, but also dynamic response across engine speed. This is relevant because the S2N and S2N+ packages may differ in ways that influence both steady internal airflow and transient intake behaviour.

The literature suggests that plenum volume can have a measurable effect on performance, but not in a simple linear way (Hamilton & Lee, 2008), finding that performance improved as plenum volume increased, with substantial gains in peak power across the tested range. Their study is useful because it shows that plenum size is not merely a packaging variable. It can alter volumetric efficiency and torque behaviour in ways that are directly relevant to motorsport engine performance.

A related issue is resonance tuning (Brennan, et al., 2007), combining theoretical and experimental work to investigate resonance effects in a high-performance engine intake system. Similarly, (Vaughan & Delagrammatikas, 2010) show that analytical Helmholtz calculations and manifold-dynamics modelling can be used together in the design of a variable intake system for a restricted Formula SAE engine. Taken together, these studies suggest that resonance-related behaviour should be considered as part of intake-system development, especially where engine-speed-dependent performance is important.

For the present project, however, these effects should be framed carefully. Transient intake behaviour is likely to be relevant to the MCR airbox package, particularly if plenum volume differs between the S2N and S2N+ configurations, but it is more difficult to validate than steady internal flow. Transient CFD and resonance-related analysis should therefore be treated as a complementary part of the study, supported where possible by dynamometer evidence and comparative configuration analysis.

6.5 Research Gap

The literature shows that internal intake geometry can influence pressure loss, flow distribution, volumetric efficiency, and resonance-related behaviour, while CFD can support intake-system development when validated against experimental evidence (Tallio, et al., 1993; De Vita, et al., 2001; Brennan, et al., 2007; Muckova, et al., 2023). Related work also shows that intake position and surrounding bodywork can affect the external flow conditions presented to an inlet, with implications for drag, local pressure recovery, and wider aerodynamic interaction (Williams & Shires, 2002; Upadhyaya, et al., 2024). Taken together, these studies confirm that intake performance is influenced by both internal and external aerodynamic factors, and that validation is essential if CFD is to be used with confidence in design work.

However, the existing literature is limited in several ways when viewed in relation to the present project. Much of the intake literature treats internal airflow, external aerodynamic behaviour, and transient intake effects as separate problems rather than as interacting features of one package. Many studies also focus on general automotive or Formula SAE contexts rather than on a regulation-constrained race-car airbox operating within a changing whole-vehicle package. In addition, there is less published work combining steady internal CFD, exposed-inlet external-flow assessment, transient intake analysis, and comparison with mixed validation sources within a single applied motorsport study.

The present research addresses this gap by investigating the MCR-S2N/S2N+ airbox package as a coupled aerodynamic problem rather than an isolated intake component. It combines internal-flow assessment, external inlet-condition analysis, selected transient intake investigation, and validation-led comparison across different package states.

A further limitation in the published literature is that many intake studies are undertaken in design contexts with greater geometric freedom than is available here. In the Sports 2000 Duratec category, controlled components and packaging restrictions limit how far the airbox package can be altered. This increases the importance of validation-led assessment, because the challenge is not simply to propose an improved intake, but to determine what improvements, if any, remain feasible and justifiable within the rule set.

7. Methodology

7.1 Research Design

This study uses a validation-led engineering design to investigate the MCR-S2N/S2N+ airbox package within its wider vehicle context. CFD is the main analytical tool, but results are interpreted alongside available physical evidence rather than treated as self-proving.

The method is comparative and mixed. It examines external inlet conditions, steady internal airflow, and selected transient intake effects, with each stage linked to an appropriate level of validation.

Because S2N and S2N+ differ by more than the airbox alone, controlled comparison is included where practical to reduce the risk of attributing wider package effects to the airbox.

A validation-led CFD-centred design is preferred because purely experimental testing would limit flexibility and diagnostic access, while an isolated airbox CFD study would risk unrealistic inlet conditions for an externally exposed intake. Lower-order intake models may support dynamic trends, but are less able to capture the coupled external–internal behaviour central to this project.

CAD geometry preparation and any required cleanup will be carried out in SolidWorks. CFD analysis will be performed primarily in ANSYS Fluent. Where available, logged data reviewed through MoTeC will be used to support comparison with simulation and test evidence.

7.2 Study Configurations and Package Context

The study is centred on the MCR-S2N and S2N+ as related but non-identical package states. The S2N is the earlier reference configuration, while the S2N+ is the later development state; however, the wider package also differs, so direct comparison cannot be treated as an airbox-only change.

The airbox therefore remains the main focus, but it is assessed within the wider vehicle package. The principal comparison will be between S2N and S2N+, with controlled CFD comparison used where practical to reduce the influence of other package changes, including matched package cases or geometry swaps where feasible.

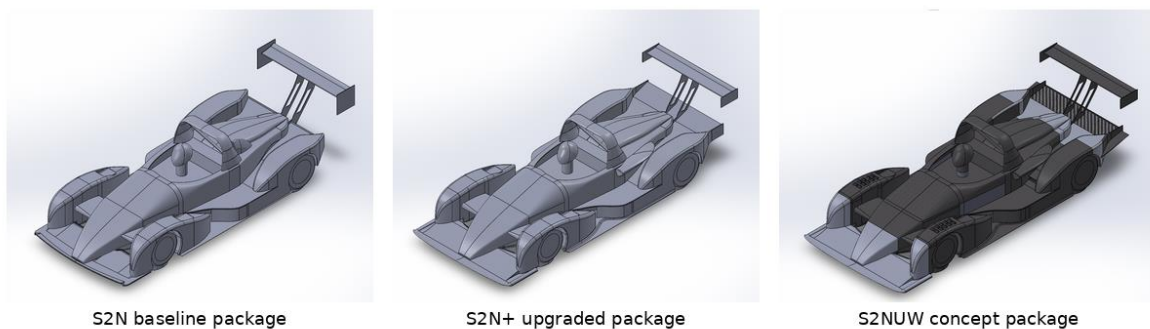


Figure 7.2-1 Study package configurations considered in the present research: S2N baseline package, S2N+ upgraded package, and S2NUW concept package.

The package context is also shaped by the Sports 2000 Duratec regulatory framework, so the airbox is assessed within a constrained design space rather than a free-form optimisation problem.

7.3 External Flow Assessment

The first analytical stage assesses the external aerodynamic conditions presented to the airbox inlet. Because the MCR intake is externally exposed, internal performance depends on the quality of the flow delivered to the inlet.

Vehicle-level CFD will be used to examine the intake region under controlled conditions representative of the available comparison data. The focus will be local static pressure, total pressure, and flow directionality in the intake region, together with the effect of nearby bodywork on pressure recovery and wake structure.

Previous Sports 2000 development work provides a useful methodological precedent, including MIRA wind-tunnel testing, track instrumentation, and wider-package CFD correlation. The SABE aero-map study also provides a relevant external-aerodynamic precedent for the platform.

Where possible, the external results will be interpreted alongside prior wind-tunnel, track, and validated package-level CFD trends. The aim is not exact one-to-one matching, but a credible definition of the inlet environment and realistic ram-air potential.

The output of this stage will be used to define the inlet boundary conditions for the internal-flow assessment.

7.4 Steady Internal Flow Assessment

Following the external stage, the methodology will assess steady internal aerodynamic behaviour of the airbox package using inlet conditions informed by the vehicle-level flow environment rather than an assumed ideal inlet.

The steady internal assessment will compare the principal configurations under consistent conditions to identify pressure loss, possible separation, and non-uniform flow development. Key outputs will include pressure-drop behaviour, velocity distribution, and flow uniformity through the airbox and horn region.

This stage is treated as part of a coupled aerodynamic assessment because internal performance cannot be interpreted independently of inlet supply conditions. Controlled comparison will also be used where feasible to reduce the risk of attributing wider package effects to the airbox.

Where available, steady internal CFD results will be compared against flow-bench data and pressure measurements to determine whether the model captures the main aerodynamic trends with sufficient credibility for engineering judgement.

7.5 Transient Intake Assessment

A further stage will investigate selected transient intake effects because intake systems do not operate only under steady-flow conditions. Pressure-wave activity means plenum volume, inlet geometry, and intake layout may influence behaviour across engine speed.

The transient study will focus on comparative behaviour rather than building a complete engine-cycle model. Where feasible, it will examine time-dependent pressure behaviour within the plenum and intake tract across a representative engine-speed range.

This stage is more demanding and uncertain than the steady internal assessment, so it will be treated as a focused comparative investigation rather than a stand-alone basis for design judgement.

Validation will rely primarily on dynamometer-supported evidence, including pressure trends and broader engine-speed-dependent response where available.

7.6 Validation and Correlation Strategy

The project will adopt a staged validation and correlation strategy because external inlet conditions, steady internal flow, and transient intake effects each require different standards of comparison.

The strongest validation is expected in the steady stages. External-flow assessment will be compared against package-level evidence where relevant, while steady internal CFD will be assessed primarily against flow-bench data and pressure measurements. Correlation will be judged using both absolute level and directional trend agreement.

Transient intake analysis will be validated more cautiously and interpreted mainly at the level of trend and comparative response rather than exact time-resolved agreement.

The model will be judged against three questions: does it reproduce the main aerodynamic trends, does it distinguish configurations in the same direction as the physical evidence, and is the agreement sufficient for the engineering judgement being made?

This staged approach is intended to build confidence progressively rather than assume that all parts of the model carry the same level of certainty.

Stage	Tool / data	Key variables	Outputs	Validation source	Decision criterion
External flow	Vehicle CFD	Package state; inlet region	Static/total pressure; flow angle	Prior wind-tunnel/track/package CFD	Credible if trends are physically consistent and directionally aligned
Steady internal	Internal CFD	Airbox geometry; inlet condition	Pressure drop; velocity distribution; uniformity	Flow-bench; pressure data	Accept if principal trends and measured behaviour agree reasonably
Transient intake	Transient CFD + dyno	Plenum volume; geometry; engine speed	Pressure fluctuation behaviour; resonance sensitivity	Dynamometer evidence; pressure trends	Use comparatively; accept where trend direction agrees
Controlled comparison	Matched CFD cases	Airbox geometry; package state	Relative change in intake behaviour	Cross-comparison of cases	Recommend redesign only if weakness is material and supported

Table 7.6-1 Operational summary of analytical stages, outputs, validation sources, and decision criteria

7.7 Design Improvement Assessment and Controlled Comparison

The final analytical stage will assess whether any further design development of the airbox package is justified, but redesign will only be considered where earlier stages identify a credible weakness or opportunity.

Any design assessment will be based on controlled comparison rather than unrestricted concept generation, because simple whole-package comparison cannot isolate the effect of the airbox with sufficient confidence.

This stage supports interpretation of the validation results and provides a structured basis for judging whether any modification is both aerodynamically beneficial and sufficiently credible to justify further development.

It will remain constrained by the Sports 2000 Duratec ruleset and practical packaging limits, with the outcome framed as a justified engineering judgement on whether the current package is adequate, requires limited refinement, or presents a clearer redesign opportunity.

7.8 Variables, Constraints and Limitations

Important variables include airbox geometry, package state, inlet conditions, plenum volume, and any configuration changes used in controlled comparison.

A major constraint is that the project is not conducted in a free design space. The Sports 2000 Duratec ruleset, together with the geometric and packaging realities of the MCR platform, limits how far the airbox package can be altered. Time, computing resource, data availability, and test access also constrain the work.

The available validation sources do not represent identical operating conditions, so correlation must be interpreted carefully and used mainly to assess trend consistency, comparative behaviour, and model credibility.

Transient intake assessment is inherently more uncertain than steady aerodynamic analysis, so any transient CFD will be interpreted as a comparative and supportive tool rather than as a complete prediction of full engine-cycle behaviour.

The project primarily uses engineering simulation and existing technical datasets rather than human-participant research. Ethical risk is therefore low, but data from university, team, or third-party technical sources will be used only with appropriate permission and handled consistently with those permissions.

8. Expected Outcomes and Significance

The expected outcome is a clearer and better-supported understanding of how the MCR-S2N/S2N+ airbox package behaves within its wider aerodynamic context, particularly in terms of external inlet conditions, steady internal flow, and selected transient effects.

At a technical level, the study should identify whether the externally exposed inlet operates in a favourable pressure region, whether meaningful ram-air benefit is likely to exist, and how strongly surrounding package features influence the flow presented to the intake. It should also clarify the steady internal characteristics of the airbox, particularly pressure loss, flow quality, and distribution.

A further expected outcome is improved separation of airbox-specific effects from wider package-level effects, even if absolute isolation is not fully possible.

Practically, the project may support decisions on whether the current package is adequate, whether limited refinement is justified, or whether a clearer development opportunity exists. Academically, it provides a focused case study in validation-led motorsport aerodynamics.

9. Project Plan and Timeline

The project will be carried out in staged form from June to August, following the validation-led structure of the methodology. The first phase will finalise the literature review, scope, package definitions, and required data and geometry.

The second phase will complete the main analytical work, beginning with external-flow assessment and then steady internal-flow assessment under more representative inlet conditions, alongside preparation of flow-bench and pressure-measurement comparisons.

The third phase will address transient intake assessment, any dynamometer-supported comparison that can be completed, and controlled comparison between package states where practical.

The final phase will focus on validation, interpretation, design judgement, and completion of the written submission.

A detailed Gantt chart is provided in Appendix A.

10. Conclusion

This proposal sets out a validation-led investigation into the aerodynamic behaviour of the MCR-S2N/S2N+ airbox package within its wider vehicle package context. Rather than treating the airbox as an isolated intake component, the study examines it as part of a coupled aerodynamic system in which external inlet conditions, steady internal flow, and selected transient intake effects may all influence performance.

The literature and methodology together support this approach. Existing studies indicate that intake geometry can influence pressure loss, flow distribution, volumetric efficiency, and resonance-related behaviour, while wider aerodynamic conditions around an exposed inlet may also affect practical intake performance. They also show that CFD is most useful when used within a structured validation framework rather than as a stand-alone predictive tool.

The proposed method begins with the external inlet environment, then assesses steady internal behaviour under more representative conditions, before extending to selected transient effects and controlled comparison between package states.

Overall, the project should clarify whether the current airbox package performs credibly, whether meaningful ram-air or package-interaction effects exist, and whether further development is justified within the Sports 2000 Duratec ruleset.

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12. Appendices

12.1 Appendix A Gantt Chart

Project Gantt Chart (June to August 2026)												
Task	Jun W1	Jun W2	Jun W3	Jun W4	Jul W1	Jul W2	Jul W3	Jul W4	Aug W1	Aug W2	Aug W3	Aug W4
Literature review and final method definition												
Collect project data, CAD, rules and baseline info												
Prepare geometry and study configurations												
External flow CFD setup and runs												
Steady internal CFD setup and runs												
Flow-bench / pressure data comparison												
Transient intake CFD												

Dyno testing and transient comparison													
Controlled comparison / hybrid model study													
Correlation and validation assessment													
Design improvement assessment													
Writing results, discussion and conclusion													
Final review and editing													

Project Gantt Chart (June to August 2026)													
Task	Jun W1	Jun W2	Jun W3	Jun W4	Jul W1	Jul W2	Jul W3	Jul W4	Aug W1	Aug W2	Aug W3	Aug W4	
Literature review and final method definition													
Collect project data, CAD, rules and baseline info													
Prepare geometry and study configurations													
External flow CFD setup and runs													
Steady internal CFD setup and runs													
Flow-bench / pressure data comparison													
Transient intake CFD													
Dyno testing and transient comparison													
Controlled comparison / hybrid model study													
Correlation and validation assessment													
Design improvement assessment													
Writing results, discussion and conclusion													
Final review and editing													
Legend													
Scheduled activity													

12.2 Appendix B Supporting Figures

The following figures provide supporting visual context for the present airbox study, including the S2N+ airbox geometry, visible package differences between S2N and S2N+, and a preliminary CFD visualisation of the new airbox.

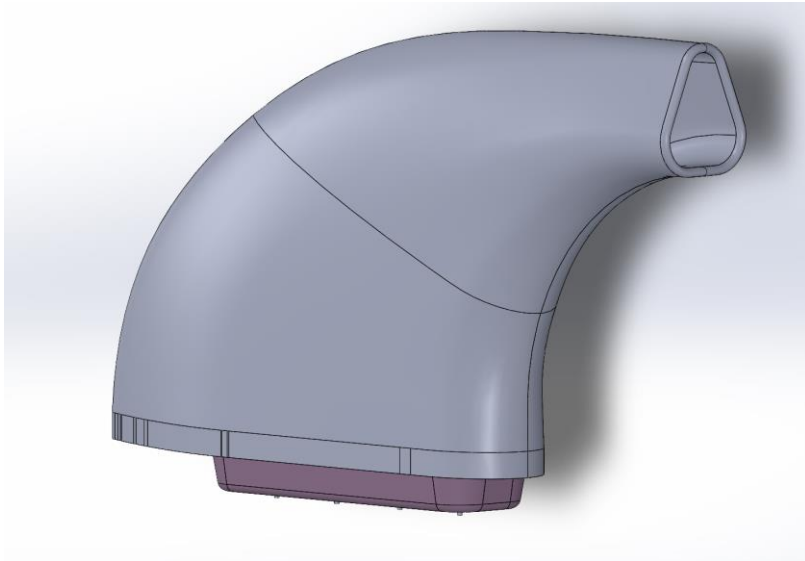


Figure 12.2-1 S2N+ airbox CAD model used as the basis for the present study.



Figure 12.2-2 Track image showing the visible difference between the S2N and S2N+ airbox arrangements.

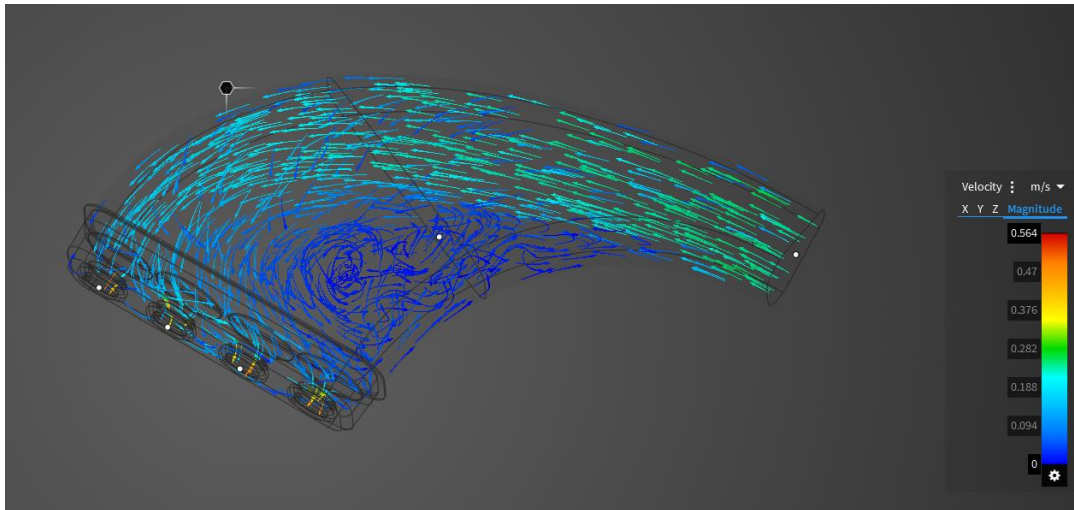


Figure 12.2-3 Preliminary CFD visualisation of the S2N+ airbox showing internal flow behaviour.

(a)



(b)

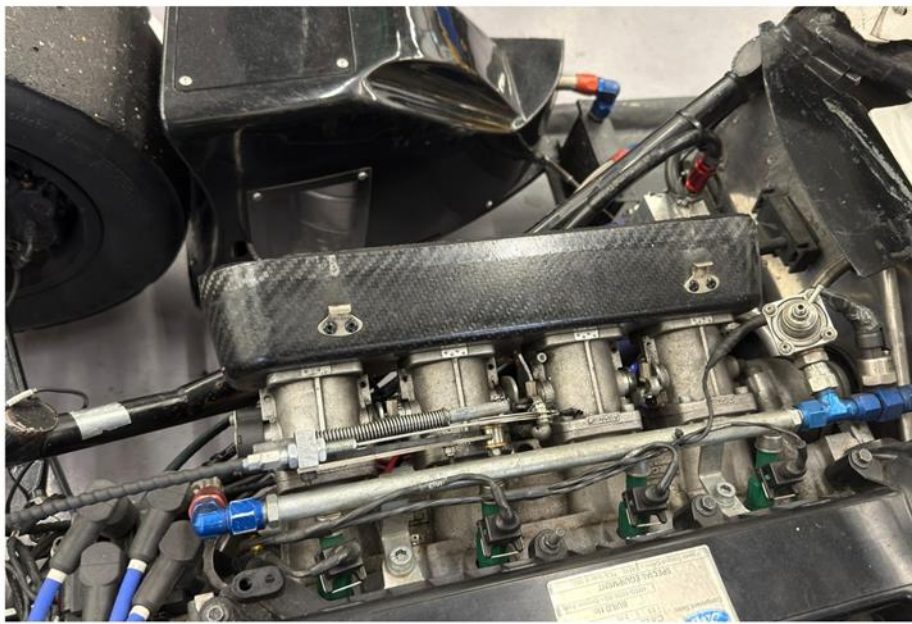


Figure 12.2-4 Reference photographs of the S2N+ airbox used to support geometry interpretation: (a) off-car view showing the plenum body and runner-entry plate; (b) installed view showing the runner interface within the wider package context.