Automotive External Aerodynamics CFD and Testing

Dr Zbynek Hrncir of ICON talks about the application of
iconCFD® Products & Services to the well-known DrivAer validation case.

03/2021 - Author: Dr Zbynek Hrncir & the ICON Team

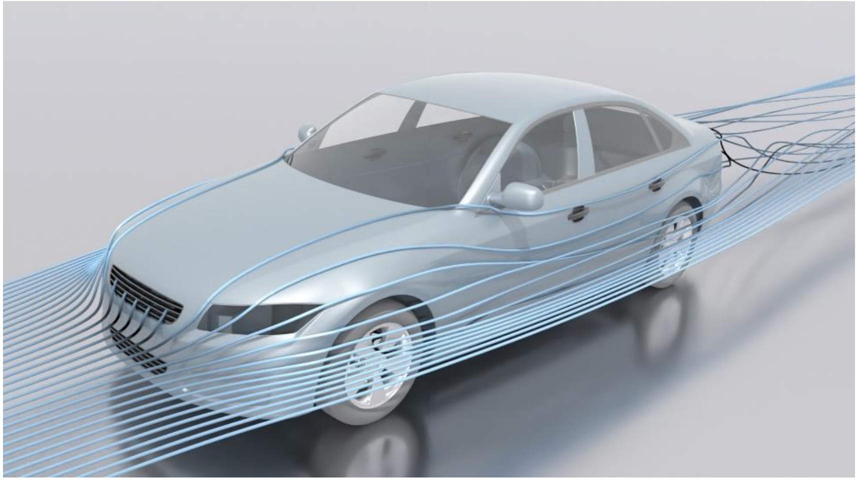

Figure 1: DrivAer car model and automatically generated photorealistic flow visualization

Presented below is the first in a series of validation cases based on the respected DrivAer geometry from TUM (Technische Universität München) representing an essential external aerodynamics test case. Simulations were carried out with both closed and open grill using iconCFD® v4.1 (2020) allowing evaluation of the software capability to predict aerodynamic drag, front and rear lift and responsiveness to changes in opening of cooling inlets. For engineering practice, the test is a suitable benchmark of software capability to predict the benefit of active shutters on CO_2 emissions and its effect on ride stability.

iconCFD® offers users the ability to run in both steady and transient modes. It allows efficient combination of more computationally expensive transient simulations to be reserved for specific cases whilst the majority can be carried out by iconCFD steady mode. Steady-state simulation, based on ICON best practice which is available to every customer of the iconCFD® product, was used for the presented validation. The simulation was run on a 90 million cell hex-dominant mesh generated by iconCFD® Mesh. All presented data are compared with experimental results provided by the European Car Aerodynamic Research Association (ECARA) and also with other CFD code results provided again by ECARA. The next part of this iconCFD® validation series which is focused on transient simulation will follow. The steady-state results are presented below:

The average accuracy of drag prediction

iconCFD in steady mode is the most accurate CFD code for drag prediction with average difference 1.87% to experimental data (*Figure 2*).

- **ICON iconCFD® (steady): 1.87%**
- Code 1 (transient): 1.93%
- Code 2 (transient): 7.43%

Outstanding drag prediction accuracy is one of the reasons why iconCFD® has been successfully certified by some of ICON's customers as a CFD method complying with demanding WLTP criteria. Comprehensive validation of drag prediction capability on an extensive group of vehicles is presented here [SAE 2017-01-1524].

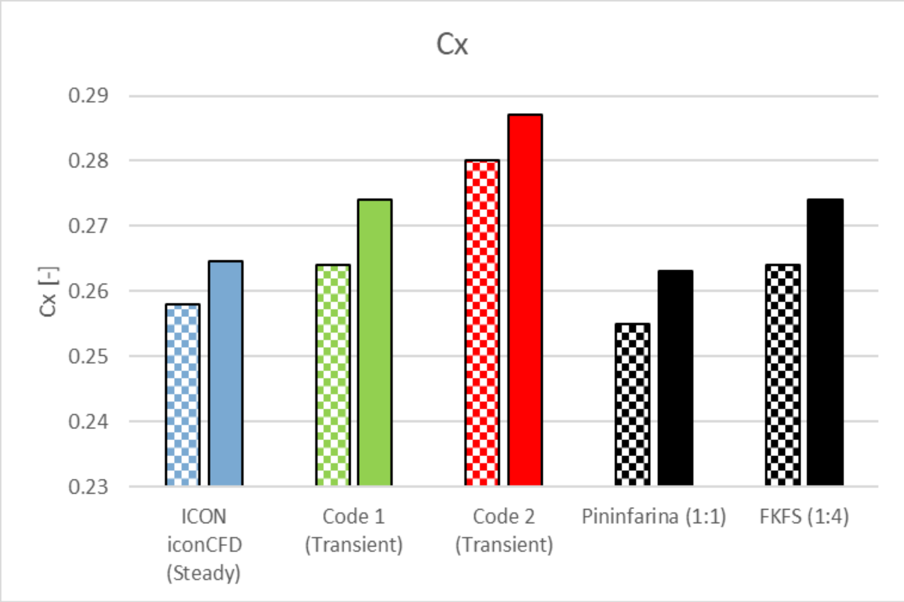

*Figure 2: DrivAer**, drag coefficient Cx, closed grill (checker fill) and open grill (solid fill)***

The average accuracy of front lift prediction

In front lift prediction iconCFD® is the most accurate by far, this time with only 4 counts average difference from experiment (*Figure 3*). Most importantly, iconCFD® is the only code which can correctly predict the switch from downforce to positive lift on the front axle when the grill is open. This is a crucial parameter for a correct assessment of ride stability and related safety risks.

- **ICON iconCFD® (steady): 4 counts**
- Code 1 (transient): 55 counts
- Code 2 (transient): 33 counts

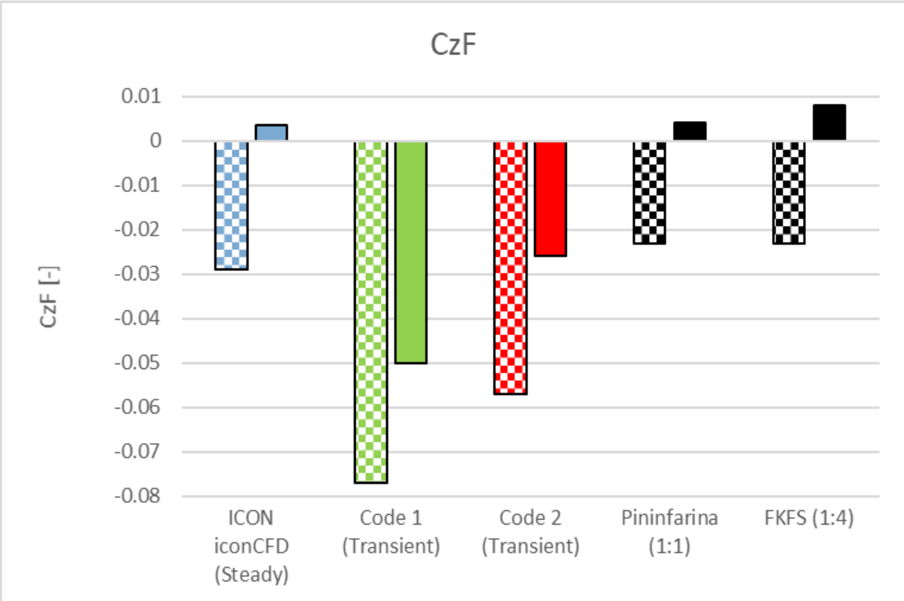

*Figure 3: **DrivAer, front lift coefficient CzF, closed grill (checker fill) and open grill (solid fill)***

The average accuracy of rear lift prediction

Average difference in rear lift prediction was 14 counts for iconCFD® which is pretty good for engineering practice (*Figure 4*). In fairness however, the two transient simulations were slightly better than steady-state iconCFD® in this aspect. Transient iconCFD results are going to be published in the next part of this iconCFD® validation series.

- **ICON iconCFD® (steady): 14 counts**
- Code 1 (transient): 7 counts
- Code 2 (transient): 7 counts

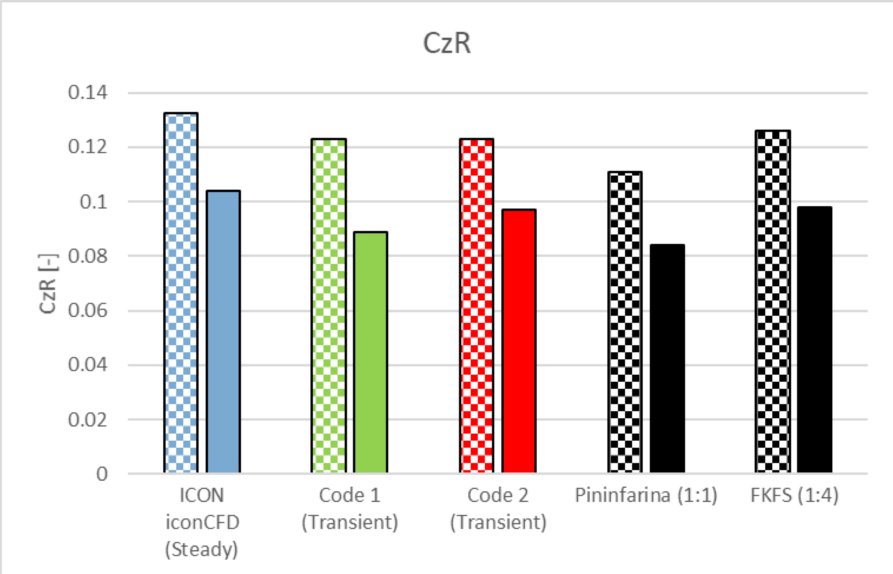

Figure 4: Rear lift coefficient CzR, closed grill (checker fill) and open grill (solid fill)

Pressure and mass flow prediction

Pressure on centreline, as calculated by iconCFD®, fits very well with the experimental data (*Figure* **5**) whereas only small differences can be found when comparing with the other CFD codes.

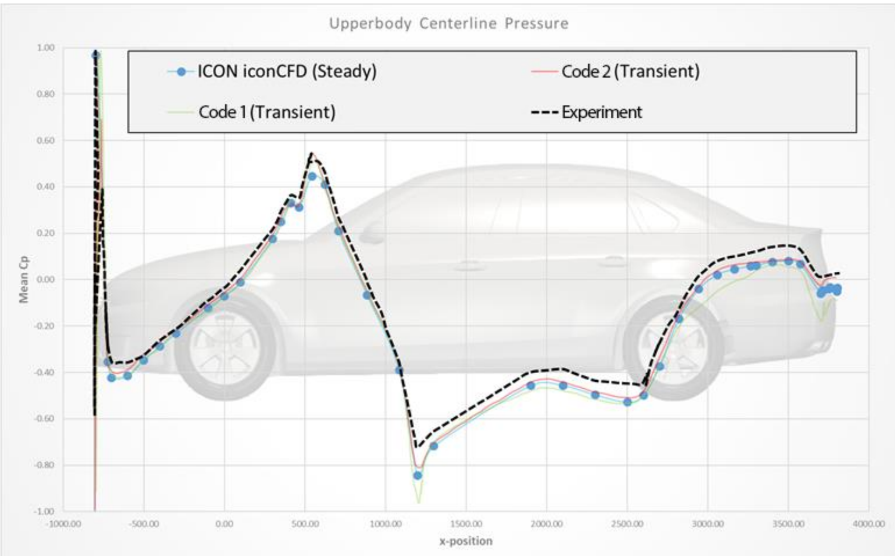

Figure 5: Pressure distribution along the car centre-line

Mass flow through the radiator predicted by iconCFD® is 1.39 kg/s, which is 0.02 kg/s (1.3%) more than predicted by the two transient simulations. We should mention that experimental data for mass flow was not available.

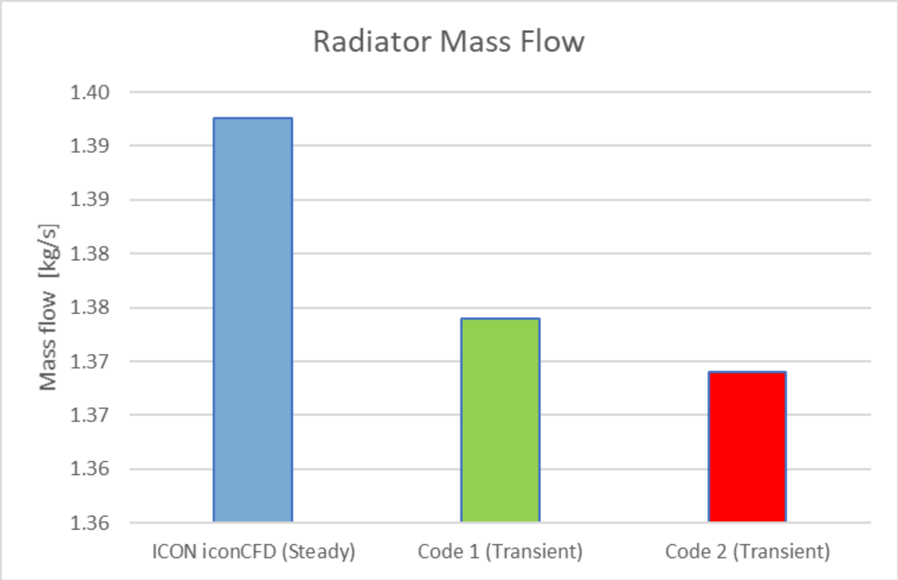

Figure 6: Mass flow through radiator

Total air mass flow through the radiator is supplied by two cooling inlets: upper and lower grille. Mass flow that comes through the lower grille is significantly higher than mass flow passing through the upper grille. The lower grille contribution is 77% of total air mass according to steady iconCFD® prediction. This ratio is slightly higher compared to predictions from the other two transient simulations (73% and 71%).

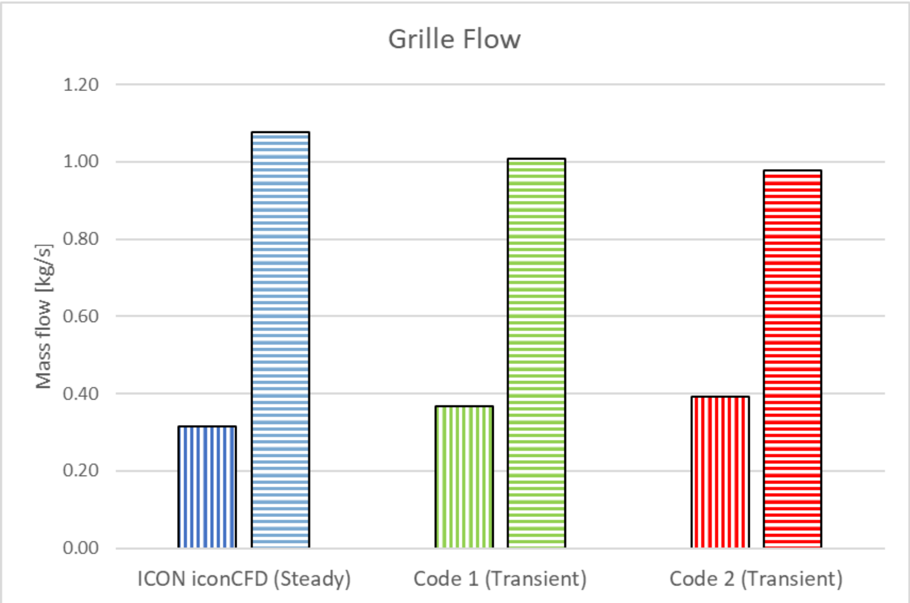

Figure 7: Mass flow through grills. Upper grille (vertical strips) and lower grille (horizontal strips)

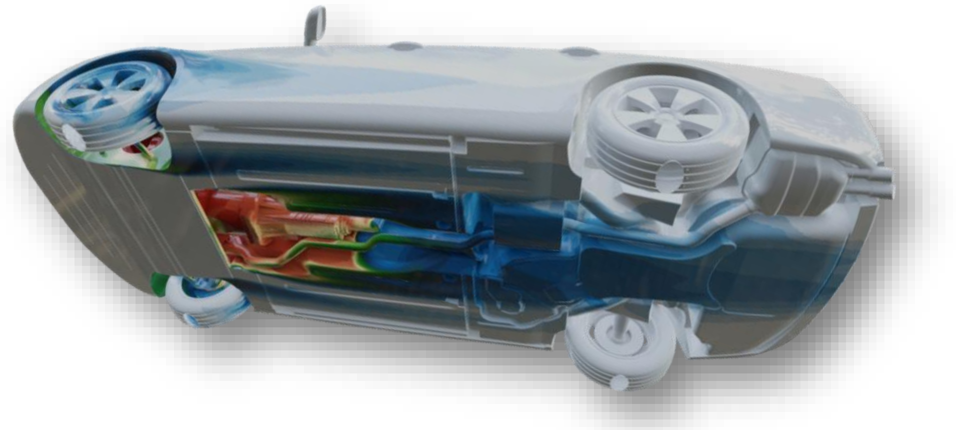

Figure 8: Contours of passive scalar concertation (PS) released from radiator. Passive scalar helps to visualize and track the air which has passed through radiator.

One iconCFD® steady simulation took **4.5hours on 288 Intel Xeon E5-2695 v4@2.10GHz** cores (1,300core-hours).

At a time when there is a demand for marginal gains, you can clearly see how ICON could help your organisation achieve that competitive edge**.** ICON is the company that started it all - unlimited open source based CFD scalability and flexibility for the automotive industry worldwide.

ABOUT ICON

For over 25 years, ICON has been a globally trusted partner for simulation-driven product engineering to world leading OEMs, emerging disruptors and suppliers. Our on-premise and cloud-based iconCFD® products and expert services deliver **significant operational, commercial and competitive benefits** to our clients – **fast, accurate, flexible and scalable** – all at **substantially** less cost than the big software vendors and conglomerates.

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- Industry experience; our people understand the issues involved and the engineering applications

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