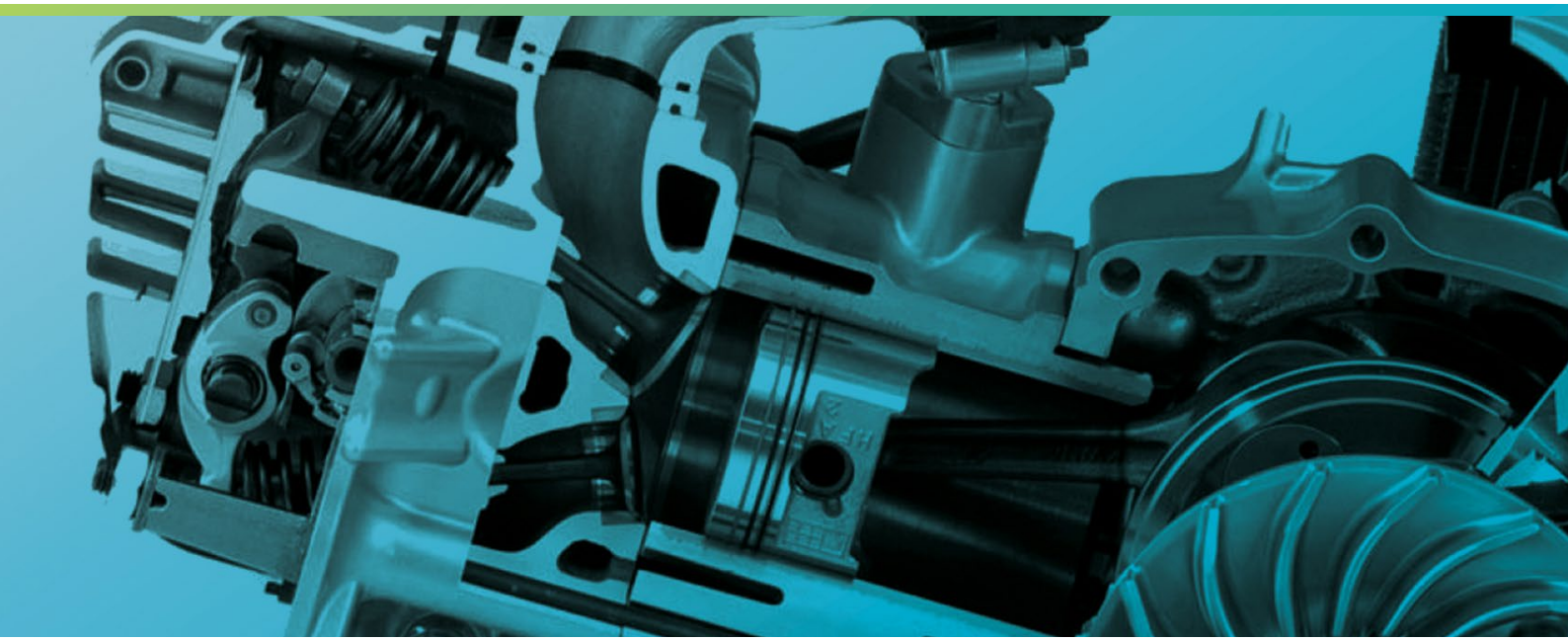
HEXAGON | Cradle

Case study

Honda R&D Co.,Ltd.

Deciding CFD tool based on thorough evaluation of benchmark model to achieve streamlining mass production process



Cradle CFD
Case study interview

The Honda Motorcycle R&D Center (R&D Center) is using SC/Tetra Computational Fluid Dynamics (CFD) software for fluid analysis of key components of Honda motorcycles. The decision to use SC/Tetra was based on results of thorough in-house benchmark tests. Using SC/Tetra, the R&D Center improved the efficiency of the development process for the test case and is now extending its use to other motorcycle components.

The R&D Center is fully responsible for research and development of Honda's domestic and non-domestic motorcycles. Within the Center, departments are divided based on their expertise, such as engine, vehicle, and fundamental research. Mr. Tomokazu Nomura (Picture 1), a Honda engineer using SC/Tetra, belongs to the Technology Development Department Two, which focuses on engine development. Their expertise is on the use and development of Computer Aided Engineering (CAE) technologies. They initially used SC/Tetra to analyze engine intake and exhaust ports and subsequently extended its application to evaluate water-cooling flow and efficiency of pumps.

The motorcycle design process starts with development, which requires determining the capability of each component to satisfy the concept requirements. Evaluation of the specifications to achieve the targeted capability comes in next. This is followed by determining the configurations, prototyping and finally, production. In the time of ever changing demands, Mr. Nomura explains that they prioritize based on minimizing delivery time for the products that the market needs.

Picture 1:
Mr. Tomokazu Nomura
Assistant Chief Engineer,
Department Two,
Technology Development Division Two,
Motorcycle R&D Center, Honda R&D Co., Ltd.

Identifying CFD software through thorough evaluation

The R&D Center first introduced SC/Tetra in 2005 to analyze engine intake and exhaust port design. Prior to the introduction of CFD, engineers repeated prototype production for many cycles during development to improve the design to ensure engine performance. Because of the amount of time this took, they wanted to reduce the number of prototypes, and make the process more efficient while retaining accuracy.
Since Mr. Nomura joined the company around the same time, he took a part in reviewing CFD software.

As Mr. Nomura's group incorporates CFD software into their daily tasks, they were looking for accurate software that is suitable for their analysis targets. To find out the software that embraces sufficient accuracy and suitability to their products, they drew comparisons between seven different analysis tools, performed analyses and undertook corresponding experiments simultaneously. Having carried out the two-year evaluation, they decided to introduce Cradle's SC/Tetra.

Honda R&D Co.,Ltd.

www.honda.co.jp/RandD/

Established	July, 1960
Business	Research and development of transportation machinery and appliances
Representative	Yoshiharu Yamamoto (CEO and President)
Capital	7.4 billion JPY

Balancing the cost, accuracy and analysis time

The R&D Center chose SC/Tetra for its high accuracy and the capability to analyze in short time. "Even if the analysis is accurate, it's no use if it takes too long to calculate," says Mr. Nomura. He was also pleased to learn that SC/Tetra was reasonable in terms of cost, for the speed and accuracy.

Another reason for choosing SC/Tetra was that it is all-in-one-package that includes mesh generating function, unlike other software that could only process the analysis calculation. Its automatic mesh generation feature was a remarkable characteristic at the time, allowing the generation of boundary layer meshes. Also, "we could choose from various visualization features. They were useful in presenting results to others," explains Mr. Nomura. He felt the usefulness strongly because back then people were not as familiar with fluid analysis results as they are now.

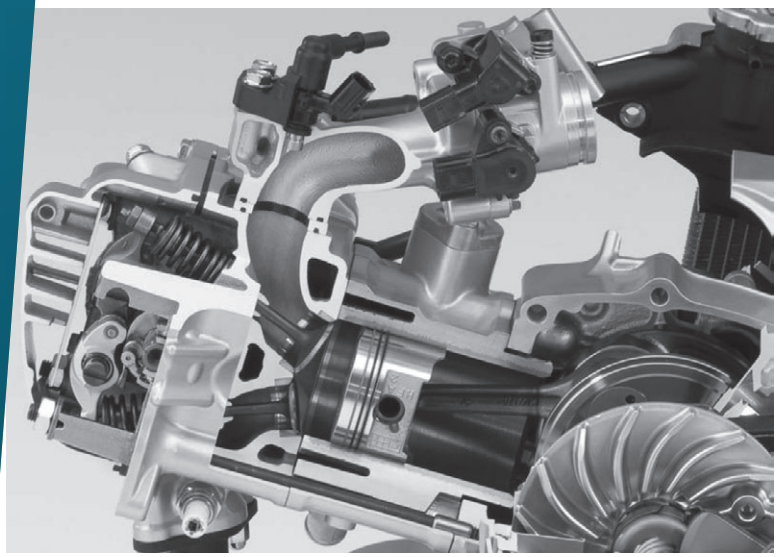


Figure 1: Cross section of the engine model showing the combustion chamber

SC/Tetra also scored very well for the software support in the evaluation; R&D Center was happy with Cradle staffs' fast and in-depth response. Its version is regularly updated, which was a crucial condition R&D Center could not compromise; ideally, CFD software should be constantly improved to become more accurate and convenient. Convinced of the ability as well as its well-balanced features, R&D Center decided to use SC/Tetra.

Successful analysis leads to increased CFD use

The global engine for Honda's 125cc scooter, PCX, was developed with CFD analysis. PCX is an internationally known brand, which aims to achieve superior environmental performance and drivability for Honda's commuter vehicle products. The engine was designed with a compact combustion chamber to produce good low-end torque with sufficient engine speed to provide adequate cooling. CFD was performed for the intake and exhaust port designs to improve horsepower and fuel efficiency. As shown in Figure 2, streamlines of air velocity within the port show that the new design enables the air-fuel mixture to flow smoothly into the combustion chamber, with reduced minimal pressure loss. This allows the air velocity within the intake port to increase even at part throttle, which improves throttle response at low- and mid-engine speeds.

With the success of CFD, SC/Tetra users in the R&D Center are actively initiating more studies of fluid dynamics on their own. Some engineers have taken the examinations to become qualified computational fluid mechanics engineers.

The R&D Center is pleased with the Cradle software. Apart from Mr. Nomura's development unit, engineers from the research development division are also starting to use SC/Tetra. With a small amount of training, they have easily started using the software on their own. Even those who had never used SC/Tetra before were able to start performing basic analyses easily.

Revalidation imperative for each new version

One major opportunity area for improvement at the R&D Center is the revalidation of the software when upgraded to the latest version. SC/Tetra is always being improved with better functionality, efficiency, and user-friendliness. However, even though an engineer may not use a specific function, a change in how the function works in the new version may affect the analysis results. For example, the upgraded version may have a function to generate a higher quality mesh but how this applies to Honda's specific analysis models must be checked and validated. "These checks aren't as thorough as the initial installation, but revalidation is still vital for every upgrade," says Mr. Nomura.

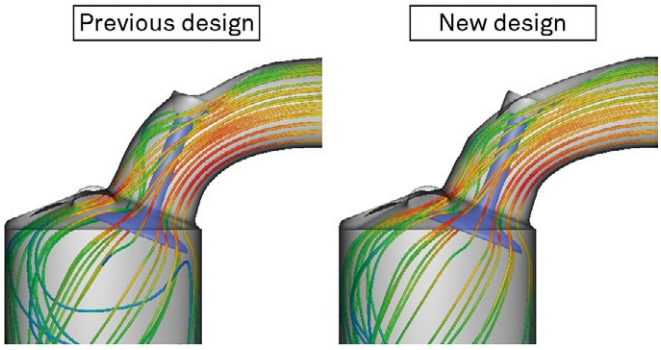


Figure 2: Streamlines of the fluid velocity within the intake port

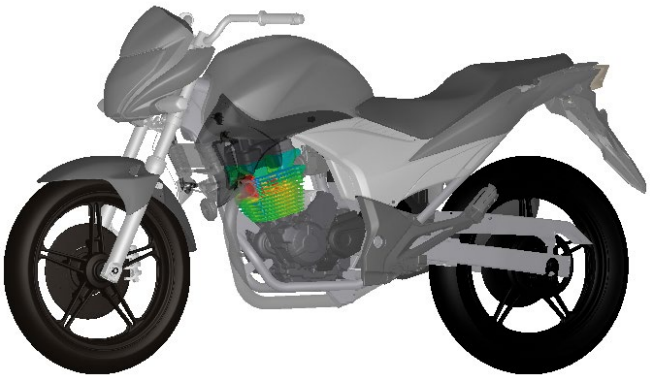


Figure 3: Temperature of CB300R air-cooling engine

Extending the range of application area and collaborating with associates

During initial software installation, the R&D Center has used SC/Tetra to analyze the air-fuel mixture within the intake port. Success in this application prompted them to expand the range of applications. Subsequently they used CFD to evaluate the engine cooling water, and pump flows, and analyze temperature distribution. The temperature distribution data is used as inputs for the structural analysis. Mr. Nomura says "material characteristics such as its elasticity and strength are dependent on temperature. We feel it's necessary to transfer thermo-fluid analysis output results to the structural analysis." His remarks indicate the importance of collaborating with other divisions, instead of isolating from each other. In Mr. Nomura's case, his colleagues and associates are physically located nearby, which made it easier to understand and stay updated about what the other team members were doing and continue to cooperate as the project progresses.

Post-analysis operations making the difference

When asked of things to keep in mind when performing a CFD analysis, Mr. Nomura makes a firm answer; "Specifying the correct input conditions is most important. In addition, post-analysis phase is also very important." Simply performing the simulation and producing the results is not enough. Engineers must decide which simulations will be performed, then predict the outcomes. Finally they must compare the results with the predictions and match the data. "I always tell our engineers that it's important to observe whether the simulation results conform to the prediction, and if not, you have to think why," says Mr. Nomura. Often, if there are no standard values or past results to assess the accuracy of the simulation results, the engineers may be deluded into blindly believing the results if they don't conduct their initial due diligence. "That's why I check with our engineers to see if they can truly confirm the design to the degree that it is accurate enough to be used for actual manufacturing," says Mr. Nomura. Getting real results that differ from the prediction is a good opportunity for engineers to think through the cause of the error - whether there was a problem with their initial thinking and understanding of the problem or whether there is a problem with the analysis process. Mr. Nomura is fortunate to have self-motivated thinkers on his team and he rarely has to point out small details.

As a result of using SC/Tetra, the R&D Center has radically reduced the number of model modifications needed after producing the test prototype. For the intake port, prototype tests resulted in some additional design changes, but much fewer than before CFD was used. Fewer changes were also made to the engine coolant passages, which were previously often modified after running actual tests.

The software was also very valuable for visualization. Engineers who aren't familiar with the powerful post-processing capabilities of CFD analysis software are amazed by the sophisticated visualization functions in the tool that make it easier to recognize the fluid flow and deepen their understanding of fluid dynamics.

Expectation for coupled analysis with 1D simulations

The R&D Center uses SC/Tetra to perform fluid analysis and collaboration with structural analysis for intake port design, but they are now planning to extend the application further. This includes coupling with one dimensional simulations and actively conducting coupling analysis using engine model simulation software and other tools.

"Optimization is our future challenge," states Mr. Nomura. Although optimization has widely been implemented in the analysis world, Mr. Nomura thinks incorporating optimization into the workflow is still premature for his team. Mr. Nomura expects large scale computing power will be needed to optimize three dimensional data. He expects that optimizing part allocation and angle modifications will be performed first before optimizing the entire model.

Mr. Nomura and his team at the R&D Center have maintained an ideal-driven attitude towards the use of CFD software. They want to use the tool that generates results in the minimum amount of time and with a very high degree of accuracy. SC/Tetra has satisfied their strict selection criteria and continues to gain credibility. Using SC/Tetra will continue to enable the R&D Center to develop quality products in less time and expand the number of product applications.

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Our technologies are shaping urban and production ecosystems to become increasingly connected and autonomous – ensuring a scalable, sustainable future.

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