Why Jatco CVT-XS took first place in IQS Part 3

This is the final issue of a series that explores why Jatco CVT-XS (hereinafter referred to as CVT-XS) won first place in the Initial Quality Study (IQS) for automobiles!
This time, we will look at the behind-the-scenes development story of the vertically mounted control valve, a first for a JATCO CVT, which contributed greatly to improving the drivability of the CVT-XS. We spoke with Sugiyama, who designed the three-way linear solenoid that improved the feeling of engine revving, Kojima, who has specialized in control valve design, and Otaki, who designed the harness layout and electrical components.

(From left) Otaki-san, Kojima-san, and Sugiyama-san

First, please tell us about what you were responsible for.

Otaki: I was in charge of designing the strainer in the first half of the project, and the electrical components and harnesses in the second half. We also designed the layout of the high-voltage harness when incorporating an electric pump in the control valve room. The CVT-XS originally had the electric oil pump in a different

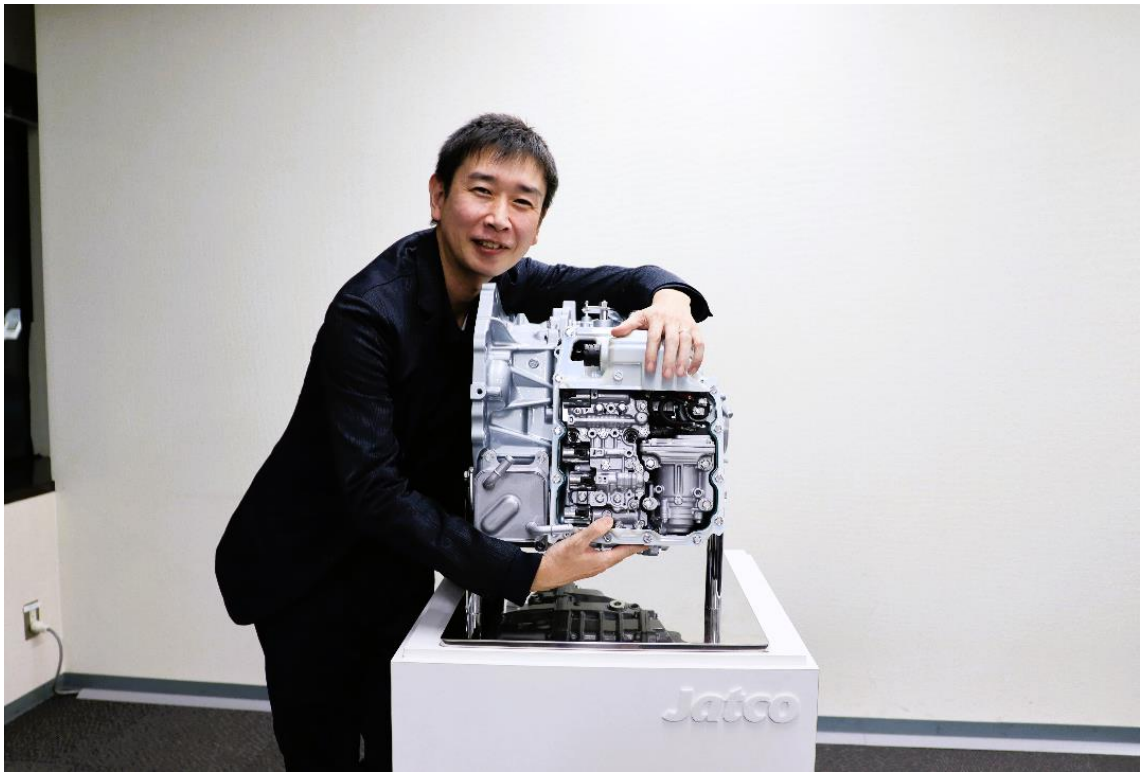
location, hanging from just a single wall alongside the mechanical oil pump, but it had to be moved due to vibration (part of the vertically mounted control valve).

Kojima: I have been designing control valves for 20 years. It's rare, isn't it? (laughs) In the early stages of the concept, just like Otaki's electric oil pump, the control valve was also placed in the oil pan chamber. Our struggle began with arranging the engine vertically with an electric oil pump to ensure ground clearance and to deal with the noise and vibration that arose later, but now it feels like a beloved child. The CVT-XS has much stricter on-board constraints than conventional models, so I'm impressed with how well it worked.

Sugiyama: At that time, there was a subsystem group that connected systems and components, and I was mainly in charge of the launch subsystem.
Its predecessor, the Jatco CVT-X (hereinafter referred to as CVT-X), was designed with hydraulic stability as the top priority. Although we were able to successfully suppress the oil vibrations (stability), it was difficult to achieve the trade-off performance of engine revving (responsiveness). I remember causing a lot of trouble when we tried to fit the car to the real thing. Therefore, the CVT-XS took on the challenge of achieving both stability and responsiveness. To achieve both stability and responsiveness, it was necessary to improve the performance of the hardware. (Direct acting lock-up solenoid, optimized valve notches) I often consulted with the two of them as we worked to realize our ideas. We also needed to optimize the dither, which is the new drive control for the solenoid, and we received a lot of help from the hydraulic experiments team. As a result, when the product was fitted to the actual vehicle, we received a "Like!" I was very happy to hear that.

What is the reason behind your success in getting the first place in the IQS?

Kojima: The first place in the IQS was an evaluation of drivability, but I think this is the result of implementing MBSE*1. It was a great relief to see all that hard work pay off. The idea is that Sugiyama designs the subsystem, Otaki's team designs the solenoid valve, which is the key component that makes it a reality, and my team assembles it with the control valve. The three of them have a strong bond.

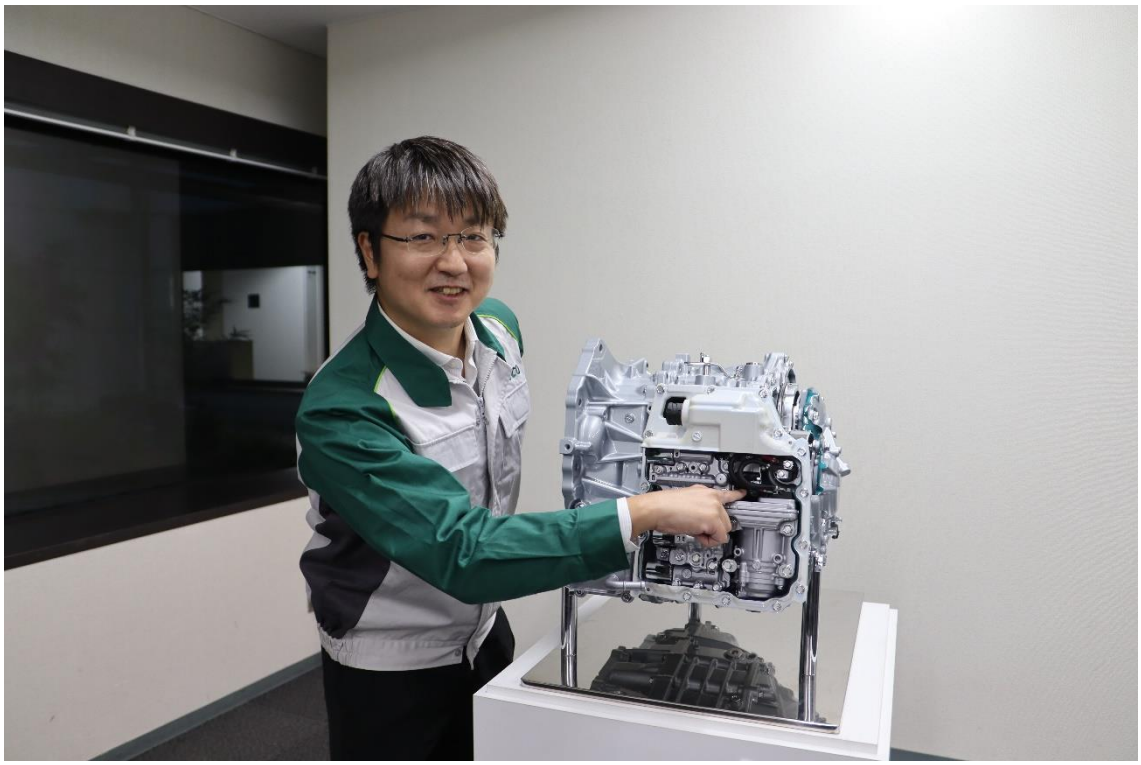


Kojima-san

How do you feel looking back on your experiences so far?

Kojima: After all, we started this project at a time when it was said to be the last CVT, so we had to see it through to the end without any regrets. No matter how experienced you are, any challenge brings anxiety. We are a generation that has suffered from malfunctions in the past, so we felt the pressure to ensure that something like that never happened again. But if you don't challenge yourself, you can't fight and you can't survive. The scenes involving modifications between lots are particularly exciting. I'm sure that experience of a malfunction is at the root of it all. That experience made us stronger.

Sugiyama: My work shifted to electrification in the latter half of the project, so I wanted to see it through to the end. In terms of improving quality, with the support of EL Michioka, the SE (systems engineering) from CVT-X was able to link the requirements, related characteristics, and specifications and sort out the trade-offs, so I think it was good that we were able to overcome some of the challenges and eliminate some of the side effects to a certain extent.



Sugiyama

Otaki: I also called it the culmination of our efforts in the "final CVT," but the vertically mounted valves were a huge challenge. Rather than a finished product, I was excited to see that they were doing something completely new. I think it was probably because of our skills that we were able to complete it in one go, which was amazing.

Otaki

Kojima: We were prepared to go through a lot of hard work and crawl on the ground to bring the product to market, but I don't think we ever faced a huge problem with no solution in sight. I think this is the result of successfully integrating requirements analysis and the means to achieve it.

Three people get excited in front of a cutaway model of the CVT-XS

What are the special features of the CVT-XS?

Otaki: Not as much as in the past, but I remember having to redo the harness several times. Other than the main harness, the control valve manufacturer had the know-how to efficiently arrange electrical components, so they were able to draw up the layout in one go. However, it was quite difficult to fit the main harness, which is made up of more than 10 harnesses, neatly into the cover. We discussed this repeatedly while working simultaneously with the production department. It's nicely put together now, but it was a lot of hard work to get it to this shape.

Otaki talking about harnesses

Kojima: The strainer was also a culmination of your work. Our goal was to create a product that is simplest, smallest, and has the best performance by far. The control valve is mounted vertically, making effective use of the extra space. The UC Lot concept was a perfect fit. We will practice four hierarchical designs, look at the balance of relative placement in the topology hierarchy, first solidify the constraints in the strength design, then do performance design, and finally do hierarchical design called Simultaneous Requirements VA! and. I think that’s the benefit of it. It's also the culmination of the V process. I think Sugiyama's meticulous design work is reflected in the results.

Sugiyama: One part I was particularly particular about was the notch (a small cutout at the end of the spool port), but it can't be seen in the cut model (laughs). The notches are there to adjust the oil flow rate. If the notch is large, a large flow rate will occur, causing oil vibrations. Conversely, if the notch is small, the flow rate is small and responsiveness decreases. By adjusting the size of the notch, we designed a shape that would achieve both stability and responsiveness. Although the notch is very small, it is an important parameter that greatly affects performance.

A place filled with memories

What do you think of the cutaway model of the CVT-XS?

Kojima: Looking at it for the first time in a while, it's still beautiful. If the layout design is poor, it will end up looking clunky and like a papier-mâché piece. We believe that aesthetic beauty is proportional to performance and quality. The control valve alone is made up of more than 100 parts, and a balanced design is implemented while making all trade-offs. I fondly recall how CTO Ozone supported me at every key juncture. Sometimes they come to see my CAD designs. At first, I thought, "It's not beautiful!" That's what I was told, but in the end, I said "Like! Beautiful!」 He said, “I'm sorry.'' I have vivid memories of visiting related departments together with Mr. Ozone to help them understand the necessity of vertical valves, and I am pleased that we have been able to commercialize this product.

Otaki: It has a glossy finish, and the colors are cute (laughs).

It's been a while since I last saw the CVT-XS, and looking at it again, I was struck by how incredibly dense the valve chamber is. There is no harness in this cutaway model, but when you imagine that there is a harness running around on top of the valve, it feels like every bit of space has been used. I remember having the front

cover adjusted down to the millimeter.

Sugiyama: The control valve is very small. I think the vertical placement meant there were more demands on the valve arrangement than with the CVT-X. Just as Kojima-san said, I think it's very beautiful.

Beautiful layout

Although you are all no longer in your respective jobs, could you tell us what you learned from the development of the CVT-XS?

Kojima: This is true for SE and R-F-L*2 function deployment, but rather than getting too caught up in the "how" of the weaving technology, it's important to ensure MECE*3 by organizing and getting to the bottom of the objectives, issues, design and verification in terms of "what." Currently, we are shifting to electrification, and I am in charge of the advanced development of the oil-cooled motor cooling system. Just like with CVTs, we are struggling with two issues: air and contamination, but this experience is coming in handy.

There are different kinds of joys too. Up until the CVT8, I was the one who drew up the blueprints and built the models myself, but with the CVT-XS, there was a generational change, and it was built by younger members, so I feel even more

attached to it.
It's only available in North America right now, but I hope it will become a product that people will remember, saying, "That car seems like a good one," or "The CVT-XS was a hit."

Sugiyama: Through the development of the CVT-XS, I was able to sense JATCO's development capabilities. Even if I were to draw out the performance I want to achieve, it would not become a product. A product is created with the cooperation of many people involved in system, sub- and component design, testing, prototyping, production, partners, procurement, and more. To communicate with the people involved, I found that my own thoughts (passion) and analytical predictions were very effective. I believe this experience will be the foundation for my future development career.

Otaki: What I learned was the importance of the three realities and R-F-L.
As for the ease of assembly of the harnesses, we had to go to the site many times and try things out on the spot. I will never forget the relief I felt when the front cover closed snugly after assembling the VC lot. Thanks to everyone who helped with the assembly.
In the previous CVT-X project, R-F-L strengthened the connection between the system and components by linking the design parameters of its own components with other requirements. With the CVT-XS, I think we were naturally able to approach our studies with an awareness of the R-F-L connection, and this is still valid now that the industry has changed.

We will continue to promote CVT-XS! (Photo taken in December 2023)

*1 Abbreviation for Model-based Systems Engineering. An approach to systems engineering that uses models

*2 Requirement, Function, Logic

*3 Abbreviation for Mutually Exclusive, Collectively Exhaustive. No omissions, no duplicates