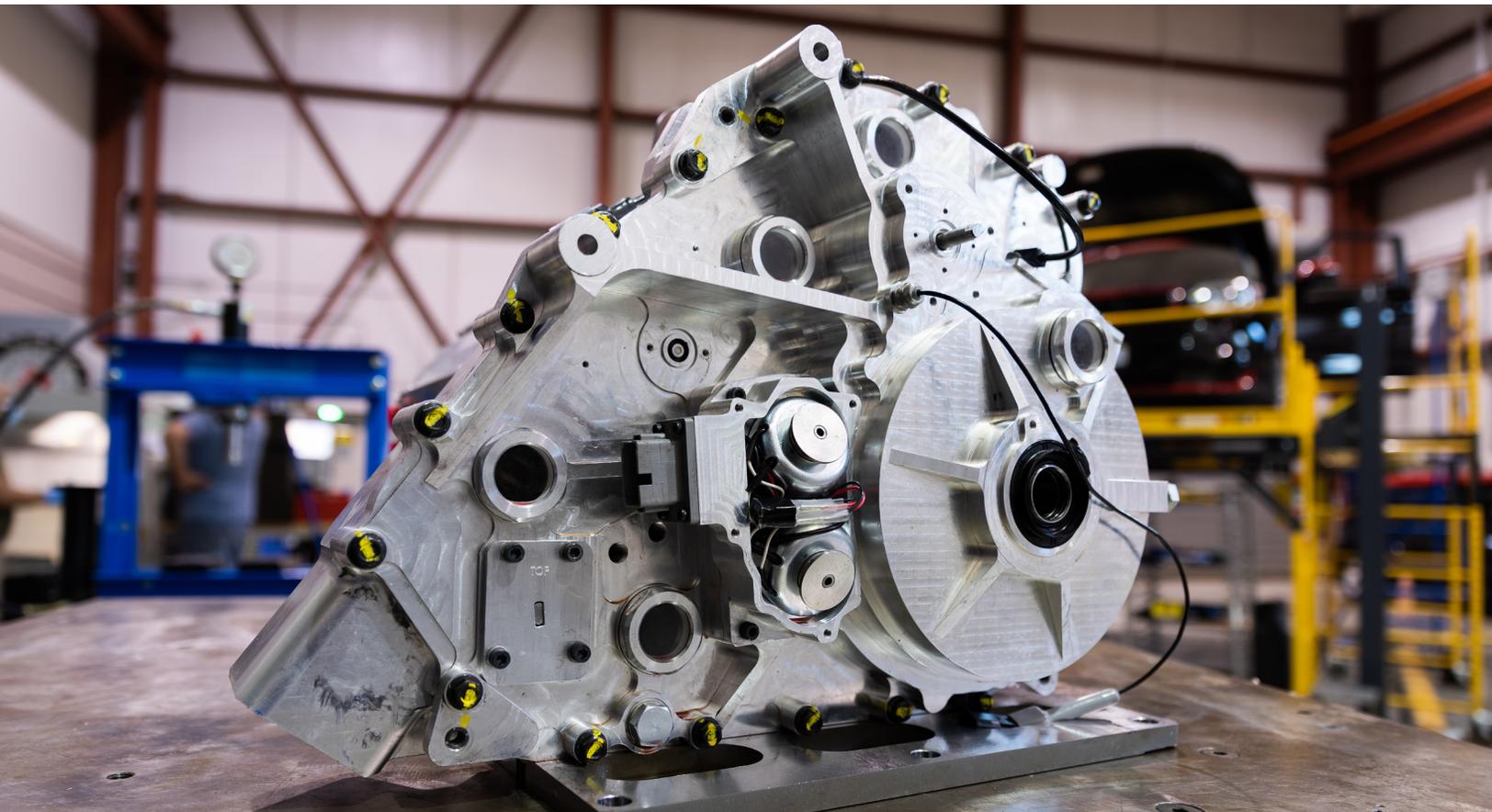


INMOTIVE, INC.

INNOVATING A MORE EFFICIENT, MULTISPEED TRANSMISSION FOR EXTENDING ELECTRIC VEHICLE RANGE WITH SOLIDWORKS SOLUTIONS

Case Study



Inmotive relied on SOLIDWORKS product development solutions in inventing the Ingear ultraefficient, multispeed transmission, which extends electric vehicle (EV) range by up to 15 percent and also improves EV top speed by up to 20 percent.

Challenge:

Quickly develop a next-generation two-speed transmission for electric vehicles (EVs) to improve transmission performance and efficiency—and extend EV range—to take advantage of the ongoing boom in EVs.

Solution:

Implement SOLIDWORKS Premium, SOLIDWORKS Professional, and SOLIDWORKS Standard 3D design and product development tools to accelerate development, and then add the SOLIDWORKS PDM Professional product data management (PDM) system to ramp up development and production in advance of commercialization.

Results:

- Fast-tracked breakthroughs and innovations
- Obtained numerous patents with more pending
- Attracted and engaged OEM Partnerships
- Extended EV range by up to 15 percent

Headquartered in Toronto, Canada, with offices in Europe and China, Inmotive, Inc. is the inventor of the Ingear™, an ultraefficient, multispeed powertrain technology for a wide range of applications. The Ingear transmission extends electric vehicle (EV) range by up to 15 percent and also improves EV top speed by up to 20 percent. Other Ingear transmission benefits include the ability to provide continuous torque during smooth, quiet shifts; a smaller footprint; and EV costs that are substantially lower. The Ingear's highly reliable design also increases torque, acceleration, gradeability, and top speed, and it is protected by 31 issued patents and 50+ patents pending.

When initial inventor, co-founder, and Chief Technology Officer Anthony Wong launched automotive Ingear in 2016, the company embarked on the challenge of evolving Wong's original ideas for an innovative, multispeed transmission for EVs into a working proof-of-concept system, and then, a fully commercialized product to be licensed by EV manufacturers and suppliers. Continuing to develop and advance the Ingear system, which required working with design team members, experts, and contributors from around the globe,



"The key aspect surrounding Ingear development was achieving innovation breakthroughs. SOLIDWORKS has allowed us to fast-track breakthroughs and innovations, resulting in a number of critical patents and IP [intellectual property] development. SOLIDWORKS was the tool that bridged the communications gap between the original inventor's concept and the final working geometry of the design. In short, SOLIDWORKS supported our ongoing drive towards innovation."

— Misagh Tabrizi, Advanced R&D Manager

demanded an easy-to-use product development and engineering system with a short learning curve to facilitate design communication, according to Advanced R&D Manager Misagh Tabrizi.

"Selecting a design modeling and communication tool that could support an efficient means of innovation was critically important for our company because we needed to work with staff located remotely—not just because of COVID-19 lockdowns but also because many of our development and validation partners are based in different parts of the globe," Tabrizi explains. "That's why we chose the SOLIDWORKS® design system. It's the perfect system for creating and optimizing our design, building proof-of-concept systems in actual cars, and supporting prototype production."

Inmotive chose SOLIDWORKS 3D design and product development tools—implementing SOLIDWORKS Premium, SOLIDWORKS Professional, and SOLIDWORKS Standard solutions—because they are easy to use, have a short learning curve, and are widely known among designers, engineers, and recent college graduates, facilitating recruitment efforts. "We haven't used any software but SOLIDWORKS for creating and adapting models, securing approvals, and designing rapid prototypes via 3D printing, and interfacing with suppliers," Tabrizi says.

FAST-TRACKING INNOVATION BREAKTHROUGHS

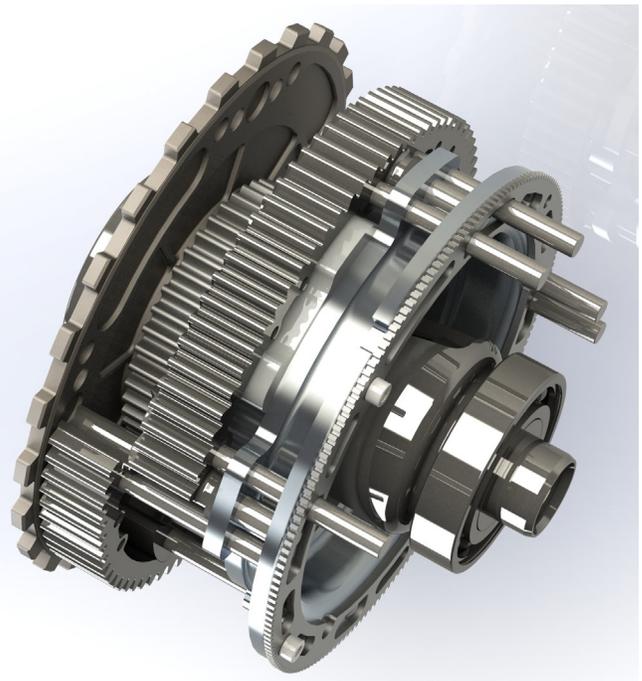
Using SOLIDWORKS design tools, Inmotive has quickly advanced Ingear development and completed proof-of-concept testing with its adapted “mule” demo car. Most EV motors on the market today use single-speed transmissions with two helical reduction gears between the motor and the wheels because the motor turns about nine times for each revolution of the wheels. Ingear replaces the second reduction gear with a continuous chain drive and an innovative, morphing sprocket that resizes during a shift. When the electric motor is able to operate more efficiently, more of the battery’s power is used to move the car, and less is wasted as motor and transmission heat. Less waste means more range from each charge.

“The key aspect surrounding Ingear development was achieving innovation breakthroughs,” Tabrizi stresses. “SOLIDWORKS has allowed us to fast-track breakthroughs and innovations, resulting in a number of critical patents and IP [intellectual property] development. SOLIDWORKS was the tool that bridged the communications gap between the original inventor’s concept and the final working geometry of the design. In short, SOLIDWORKS supported our ongoing drive towards innovation.”

COMMUNICATING EFFECTIVELY SPARKS PARTNERSHIP

Inmotive leverages solidworks tools—including high-quality images and video animations of the ingear—to effectively communicate and demonstrate how the ingear transmission operates, which is vital to attracting and engaging EV manufacturing partners. Inmotive is pleased to have signed a joint development agreement with Suzuki in early 2023 to develop an Ingear two-speed transmission for a future Suzuki EV.

“SOLIDWORKS has truly been an accelerating tool for us, enabling us to quickly progress from initial ideation to the testing bench,” Tabrizi notes.



Using SOLIDWORKS solutions, Inmotive has been able to fast-track innovations—such as the ability to provide continuous torque during smooth, quiet shifts; a smaller footprint; and EV costs that are substantially lower—and communicate these advances using high-quality SOLIDWORKS images and video animations to attract potential EV manufacturing partners, like the joint development agreement it signed with Suzuki in early 2023 to develop an Ingear two-speed transmission for a future Suzuki EV.

PREPPING FOR COMMERCIALIZATION WITH SOLIDWORKS PDM

As Inmotive grows, the company plans on adding the SOLIDWORKS PDM Professional product data management (PDM) system to its SOLIDWORKS implementation to tighten revision controls and improve data security. "Our goal is to develop best-in-class transmissions for EVs, and as we embark upon the commercialization phase, we simply need a better solution for managing our growing volume of product design data," Tabrizi points out.

"The two-speed Ingear transmission is only the beginning, and future plans to develop three-speed (or more) transmissions is not impossible," Tabrizi adds. "As our development effort grows, we'll look to the SOLIDWORKS PDM system to support our development needs just as SOLIDWORKS design tools have."

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