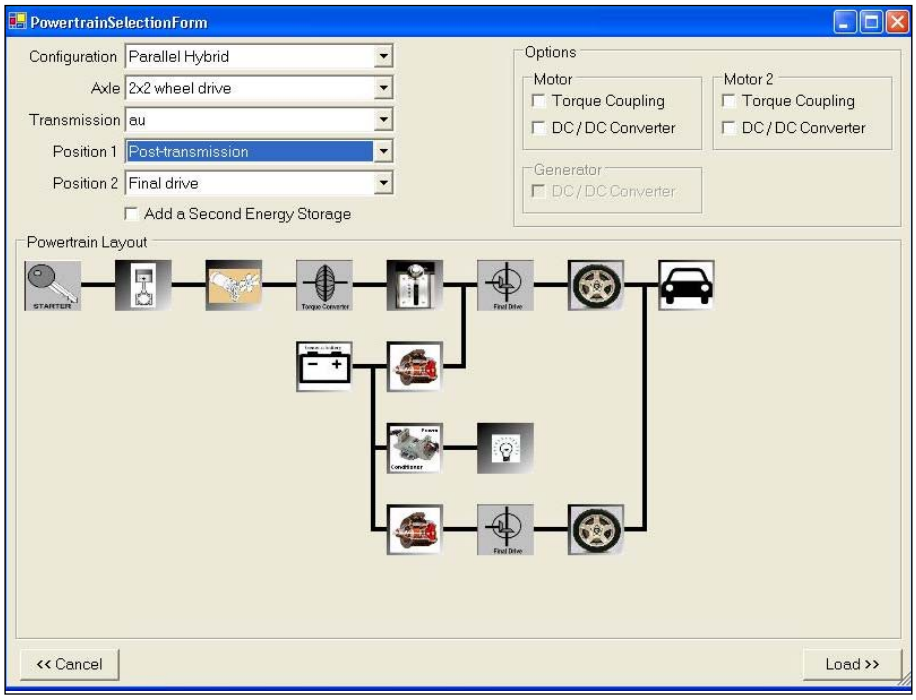
Success Story

PSAT Accurately Simulates Advanced Vehicles

Background

In an increasingly competitive world, the role of simulation in vehicle development is critical. Because of the large number of possible advanced vehicle architectures, it is impossible to build every single powertrain configuration manually due to time and cost constraints. The Powertrain Systems Analysis Toolkit (PSAT) is a state-of-the-art flexible and reusable simulation package, sponsored by the U.S. Department of Energy (DOE) and developed by Argonne National Laboratory.

Serving as a single tool applicable to multiple projects, PSAT allows engineers to efficiently and cost effectively reuse previous work. It gives automotive and truck manufacturers and their suppliers the ability to efficiently assess advanced technologies and support their product decisions. The software is a graphical user interface (GUI)-driven application, which makes it very easy to use.



The software simulates several hundred predefined configurations, including conventional, electric, hybrids, and fuel cells.

Technology

With PSAT, a driver model follows any standard or custom driving cycle, sending a power demand to the vehicle controller, which, in turn, sends a demand to the propulsion components (commonly referred to as "forward-facing" simulation).

Component models react to the demand and feed back their status to the vehicle controller, and the process iterates on a sub-second basis to achieve the desired result (similar to the operation of a real vehicle controller). Because of its forward architecture, PSAT component inter-actions are "real world."

Developed with Matlab/Simulink, the software simulates several hundred predefined configurations, including conventional, electric, hybrids, and fuel cells. Users can also choose two-wheel drive and four-wheel drive. Such a capability is only possible due to PSAT's ability to build all these drivetrain configurations according to the user's inputs, drawing from a large library of component models.

Using test data from Argonne's Advanced Powertrain Research Facility, conventional and mild-hybrid vehicles

have been validated within 2% and full hybrid vehicles within 5% for both fuel economy and battery state-of-charge on several driving cycles.

PSAT gives users the capability to:

- Study fuel economy
- Simulate performance and gradeability
- Size components
- Perform parametric studies
- Compare
  - Component technologies
  - Control technologies
  - Drivetrain configurations
- Integrate proprietary
  - Drive cycles
  - Data
  - Component models
  - Control strategies
- Define component and vehicle-level requirements
- Import test data
- Animate and compare test and simulation data

Commercialization

Since PSAT is so flexible, Argonne and other users have applied it to a wide range of applications, such as validating models of advanced vehicles (e.g., the Toyota Prius, Honda Insight, and Ford P2000); simulating advanced vehicles for industry, the U.S. Army, and student competitions; evaluating the potential of fuel cell and hybrid technologies; conducting fuel cell sub-system and system requirements and energy storage requirements for fuel cell vehicle applications; well-to-wheel evaluation of advanced vehicles with the Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation (GREET) model (http://greet.anl.gov); and teaching and research.

Overall, several hundred representatives from industry, academic, and government sectors have downloaded a demo version of PSAT from Argonne's transportation website. Licensed PSAT users to date include major automotive suppliers, energy companies, research institutions, and universities.

PSAT is already widely used by major companies and universities through DOE subcontracts. These users include Ford Motor Co., DaimlerChrysler Corp., General Motors Corp., VALEO, and University of Michigan, Ohio State University, Penn State University, University of California-Davis, and University of Wisconsin-Madison

To download a 30-day demo model, go to Argonne's transportation website (www.psat.anl.gov).

Benefits

- Flexibility
- Reusability
- User friendliness
- "Real world" interactions
- Large number of powertrain configurations
- Innovative post-processing tools

"We have been working on the modeling, simulation, and testing of fuel cell and other alternative powertrains. PSAT, developed by Argonne National Laboratory, is one of the major simulation packages we have chosen to leverage our research. There is a rich collection of models for advanced powertrains in PSAT. These will certainly accelerate our research."

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A Strong Energy Portfolio for a Strong America

Energy efficiency and clean, renewable energy will mean a stronger economy, a cleaner environment, and greater energy independence for America. Working with a wide array of state, community, industry, and university partners, the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy invests in a diverse portfolio of energy technologies.

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