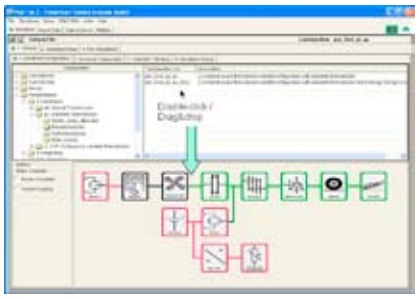
PSAT Accurately Simulates Advanced Vehicles

Background

In an increasingly competitive world, the role of simulation in vehicle development is critical. Because of the numerous new powertrain systems being examined for fuel cell and hybrid electric vehicles that can offer reduced dependence on fossil fuels, time and cost constraints preclude the physical building and testing of the many possible configurations. Instead, the necessary evaluations can be done via simulation tools, provided these are sufficiently powerful and accurate. Argonne National Laboratory (ANL), sponsored by the U.S. Department of Energy, developed the Powertrain System Analysis Toolkit (PSAT) to provide such a simulation tool. PSAT is a state-of-the-art flexible and reusable simulation package that 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; and its extensive embedded library of models allows engineers to efficiently and cost-effectively reuse previous work. PSAT received an R&D100 Award in 2004; the awards highlight the 100 best products and technologies newly available for commercial use from around the world.

The Technology

PSAT was designed to meet the requirements of automotive engineering throughout the development process. PSAT is transportable from the virtual world of component modeling and simulation to the emulated environment of component control in hardware-in-the-loop (HIL) testing in PSAT-PRO (companion software), and then to the physical environment of full powertrain control in a vehicle. This capability, when combined with the engineering, development, and testing resources at Argonne, has substantially enhanced DOE's ability to assess the potential of advanced automotive technologies and streamline the development process for promising technologies. With PSAT, a driver sends commands to the vehicle controller, which, in turn, sends a demand to the propulsion components to follow the desired vehicle speed trace. 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 is used to optimize a vehicle and its components with regard to the following:

- Fuel consumption for any driving cycle or profile
- Vehicle performance, including acceleration and grade
- Drivetrain configuration, including conventional, electric, fuel cell, series hybrid, parallel hybrid, and power split hybrid
- Realistic control strategy
- Component technologies
- Component sizing
- Transmission ratios

Commercialization

PSAT has been applied to a wide range of government, industry, and academic applications. It has been used to validate models of advanced vehicles (for example the Toyota Prius, Honda Insight, and Ford P2000); to simulate advanced vehicles including hydrogen-fueled vehicles; to evaluate the potential of fuel cell and hybrid technologies; to evaluate fuel cell sub-system, system and energy storage requirements for fuel cell vehicle applications; and to teach, train, and research. PSAT has 46 licensed institutions to date, including ExxonMobil, Lockheed Martin, DANA, Electric Power Research Institute, Mississippi State University, University of Alabama, and Braunshweig University in Germany. Others using PSAT through U.S. Department of Energy subcontracts include Ford Motor Company, DaimlerChrysler Corporation, General Motors Corporation, Valeo, and many universities.

Benefits

- Forward-looking model that provides “real world” interactions
- Written in MATLAB/Simulink/ Stateflow to ensure modularity and flexibility
- Offers a wide range of light- to heavy-duty vehicle applications
- Accurate simulations
- Designed for co-simulation environments
- Complete Simulink models and data sets provided
- Multiple-option component model libraries
- Reusable due to the extensive embedded library of models
- User friendly graphical user interface.
- Unrivaled number of pre-defined powertrain configurations.
- Extensive HTML and PDF documentation

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