Argonne NATIONAL LABORATORY

Transportation Technologies

NEW

POWERTRAIN SYSTEMS ANALYSIS TOOLKIT (PSAT)

A FLEXIBLE, REUSABLE MODEL FOR SIMULATING HYBRID AND OTHER ADVANCED VEHICLES

2004 R&D100 Award Winner

BENEFITS

- Quick comparison of powertrain configurations, hybrid and other component technologies and control strategies without costly hardware
- Easy-to-navigate graphical user interface
- Large number of predefined powertrain configurations
- Complete Simulink models and data sets are provided
- Innovative post-processing tools to analyze drivetrain behavior
- "Real-world" interactions and data set libraries
- Capable of providing extensive HTML and PDF documentation.

FEATURES

PSAT allows users the capability to:

- Simulate a wide range of light- to heavy-duty hybrid and fuel cell vehicle applications
- Study fuel economy on different hybrid vehicle configurations for both cars and trucks
- Simulate performance and gradeability (hill climbing)
- Access multiple-option component model libraries
- Compare component technologies, control strategies, and drivetrain configurations
- Integrate industry proprietary drive cycles, data, component models, and control strategies.

The Challenge

Because of the large number of possible advanced vehicle architectures, including gasoline, diesel, electrical, hybrid, and fuel cells, it is impossible to manually build every single powertrain configuration due to time and cost constraints. Because of this, the role of simulation in vehicle development has become critical to automakers and suppliers.

The Solution

To address this important issue, Argonne National Laboratory, under a contract sponsored by the U.S. Department of Energy (DOE), developed the Powertrain Systems Analysis Toolkit (**PSAT**), a flexible, reusable model for simulating advanced vehicles.

PSAT is a key tool for designing advanced hybrid vehicles.

Selected by the U.S. Department of Energy (DOE) as its primary vehicle simulation tool to support its FreedomCAR and Vehicle Technologies Program, **PSAT** received R&D Magazine's prestigious 2004 R&D100 Award, which recognizes the 100 most technologically significant new products & processes from around the world in a calendar year. **PSAT** provides automotive and truck manufacturers and their suppliers the ability to assess advanced technologies by providing accurate performance and fuel economy simulations.

Developed with Matlab/Simulink, the graphical user-interface (GUI)-driven application simulates more than 400 predefined configurations. These include conventional, electric, hybrid and fuel cell vehicles. This capability is possible because **PSAT** is able to build all drivetrain configurations according to users' inputs, with a drag and drop model building approach, drawing from a large library of component models.

PSAT Performance Validation

Using test data from Argonne's Advance 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.

CONTACTS

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STATUS

PSAT is currently available through licensing agreements available at the Argonne Software Shop at http://www.anl.gov/techtransfer/Software_Shop/index.html

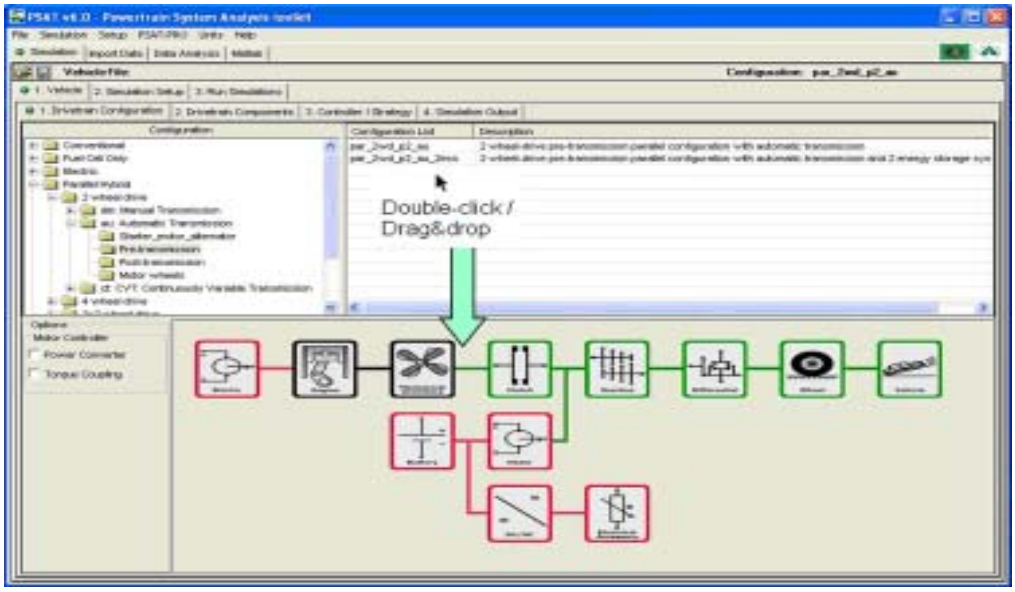
ABOUT ARGONNE TECHNOLOGY TRANSFER

Argonne National Laboratory is committed to developing and transferring new technologies that meet industry's goals of improving energy efficiency, reducing wastes and pollution, lowering production costs, and improving productivity. Argonne's industrial research program, comprising leading-edge materials research, cost-saving modeling, and unique testing and analysis facilities, is providing solutions to the challenges that face U.S. manufacturing and processing industries.

How PSAT Operates

PSAT component interactions are based on "real-world" scenarios. Because of this, control strategies can be implemented directly and tested on the bench or in an actual vehicle (using **PSAT-PRO**).

With **PSAT**, a driver model follows a standard or custom driving cycle, sending a power demand to the vehicle controller, which in turn, sends a demand to the propulsion components. Component models react to the demand and feed back their status to the vehicle controller. The process repeats itself on a sub-second basis to achieve the desired result (which is similar to how a real vehicle controller operates).



Select Drivetrain Configuration

PSAT Versions

PSAT Version 6.0 was released in September 2005. A detailed demonstration is available at http://www.transportation.anl.gov/software/PSAT/PSAT_Demo/index.html. Free registration is required to access this website.

APPLICATIONS

Because of its flexibility, **PSAT** has been used by Argonne and other users in a wide range of applications, such as:

- Validating models of advanced vehicles (e.g., Toyota Prius, Honda Insight)
- Evaluating potential of advanced vehicles for U.S. DOE, the industry, the U.S. Army, and student competitions
- Evaluating the impact of vehicle mass reduction on advanced vehicles
- 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://www.transportation.anl.gov/software/GREET/index.html)
- Education and research.

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