

PSAT: An Industry Standard Model for Automotive Engineering

The Powertrain System Analysis Toolkit (PSAT), developed by Argonne National Laboratory and the U.S. Department of Energy (DOE), is a unique simulation tool designed to serve as a single source for automotive engineers to use throughout the design process — from modeling to control.

The Challenge

Because hybrid-electric vehicles provide much better fuel economy and emissions performance than conventional vehicles and offer a viable short-term approach to reducing oil consumption, vehicle manufacturers are focusing their research dollars on introducing these advanced vehicles to the automotive market. There are hundreds of possible powertrain configurations that need to be considered in developing each new model type. Developing all these configurations would be time- and cost-prohibitive, so vehicle makers and suppliers need modeling software to narrow their choices to a manageable number that can be implemented in actual test vehicles.

Our Solution

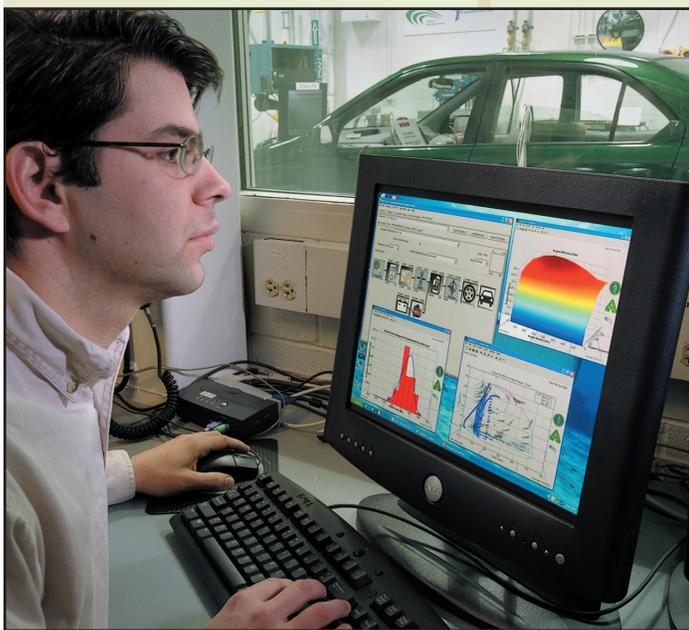
Development of PSAT began with a request from the Partnership for a New Generation of Vehicles (PNGV) (Ford, General Motors, DaimlerChrysler, and DOE) for a model to optimize hybrid-electric vehicles. The automakers wanted a model that all the partners could use to work on collaborative projects. That tool was the forerunner of PSAT.

Working closely with the PNGV partners, Argonne refined the software package by rewriting the code, adding a graphical user interface, and allowing users to compare test data with simulation data. The three automakers agreed to release a nonproprietary version of the software in 2003; further improvements yielded the version of PSAT that is distributed today.

Our Approach

The main strategy in developing PSAT was to make the software as flexible and user-friendly as possible. Argonne strengthened PSAT's analytical capabilities, increased the number of configurations that PSAT could simulate (currently more than 400), and improved the model to ensure effortless integration of virtually any proprietary models, controls, and driving cycles — making PSAT truly unique. (The model is available on the Argonne Software Shop web site [http://www.anl.gov/techtransfer/Software_Shop/PSAT_NP/PSAT_NP.html] with a downloadable video demonstration that offers an extensive review of PSAT capabilities.)

Since then, Argonne has worked hard to make PSAT accessible to new users through journal articles, presentations, conference papers, and the extraordinary degree of technical support offered to current users. The PSAT development team is in constant contact with users, who often request new features for new types of studies. When the new features will benefit users generally, they are incorporated in subsequent releases of the software. This support is provided to all users, large and small.



The Outcome

- ▶ PSAT has been licensed by over 60 organizations — 34 universities, 28 companies, and 7 government agencies — in the United States and abroad.
- ▶ The package is used by major automotive companies and suppliers to support the development of advanced vehicles and components.
 - ✓ Automotive Companies — Ford, General Motors, Chrysler, Hyundai Motor Corporation
 - ✓ Major Suppliers — Delphi, SK, LG
 - ✓ Heavy-Duty Equipment Companies — ArvinMeritor, Caterpillar, Cummins, DANA, International, John Deere, Lockheed Martin, PACCAR
 - ✓ Oil Companies — Chevron, Exxon Mobil
- ▶ PSAT was selected by DOE as the primary simulation tool to support its FreedomCAR and Vehicle Technologies Program
- ▶ PSAT received an R&D 100 Award (2004), which highlights the 100 best new commercial products and technologies from around the world, and the Federal Laboratory Consortium Award for Excellence in Technology Transfer (2007), which recognizes scientists who use innovative means to successfully transfer technology from a federal laboratory to the marketplace.
- ▶ PSAT has become one of the most widely distributed and executed software licenses at Argonne.

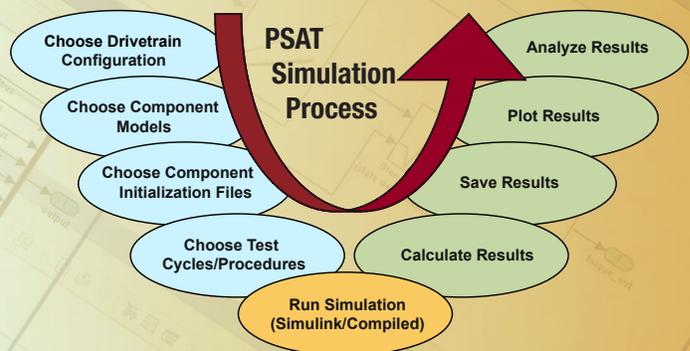
Future Work

A recent Cooperative Research and Development Agreement (CRADA) between Argonne and General Motors is aimed at developing an enhanced version of PSAT to serve as the basis for the development of an industry standard for vehicle and component modeling. Successful completion of this project would put PSAT at the center of a revolution in advanced vehicle design by permitting models to be developed through a common language and a common means of exchanging technology.

In the long term, the developers of PSAT hope that their software will help foster the development of fuel cell and hydrogen-fueled vehicles and contribute to eventual petroleum independence by transportation sectors worldwide.

What PSAT Offers

- ▶ A wide range of powertrain and vehicle configurations and a user-friendly graphical interface
- ▶ Multiple-option component libraries and management of component compatibilities through a database
- ▶ A wide range of data analysis options — from diagrams and plots to animation
- ▶ Through its extension (PSAT-PRO), the model is transportable from virtual component modeling, to emulated component control, to physical powertrain control in a vehicle



What Our Customers Are Saying

OEMs have limited resources and research funds for new technologies. We have to pick and choose very carefully where we put our money and in what technology. In PSAT, DOE and Argonne have developed a tool that helps speed up the process and allows us to look at many different technologies much sooner than we would otherwise. We need a model that's intuitive, easy to use, and provides accurate results. PSAT gives us that.

— Randy Yost, Engineering Specialist in Analytical Tool Development at General Motors Corporation

Sponsor

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