

Tutorial on Autonomie, a Plug-and-Play Software Architecture



Overview of Autonomie

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Energy Efficiency and Renewable Energy

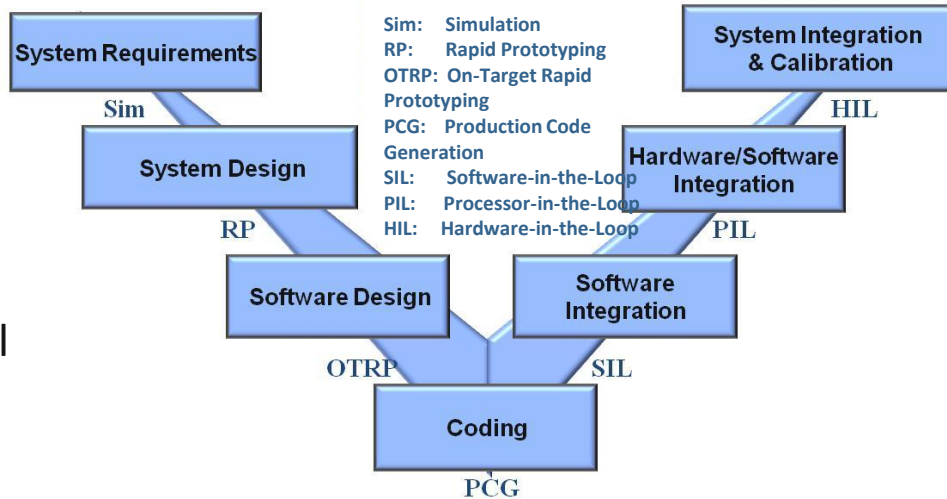
Bringing you a prosperous future where energy is clean, abundant, reliable, and affordable.



Reliance on Modeling & Simulation Is Continuously Increasing

- Reduces cost and time to production

- Allows thorough multidisciplinary integration and testing **in the virtual environment before hardware is built**
- Sorts** technologies quickly to reduce hardware iterations
- Promotes **parallel** and integrated virtual development of control systems and hardware
- Reduces/**eliminates duplicate** modeling and analysis work and activities



- Enables fast adoption of new technologies

- Delivers better **integrated**, initial designs that balance Fuel Economy, Emissions and Drivability (FEED) requirements.
- Provides **common** methods and tools for comparing/evaluating technologies.
- Facilitates efficient, seamless **link from research to production** to maximize reuse of work products and eliminate waste.



Argonne Developed PSAT to Support R&D and Management Decisions

- Selected in 2004 as the **primary vehicle modeling tool** for vehicle technology activities funded by the U.S. Department of Energy (DOE) (FreedomCAR, 21st Century Truck Program)
- Received several awards:
 - 2004: **R&D100 Award** (100 most technologically significant new products and processes introduced into the market each year).
 - 2007: **Federal Laboratory Consortium Technology Transfer Award**
 - 2010: **DOE Vehicle Technology Program R&D Award**
- PSAT is currently used by more than 130 companies and 700 users worldwide, including GM, Ford, Chrysler, Hyundai, Toyota



Autonomie: Taking it to the Next Level

- Developed through a *Cooperative Research and Development Agreement* (CRADA) with General Motors
- To be released in late 2010
- The objective is :
 - to **accelerate** the development and introduction of advanced technologies
 - to define a **Plug&Play architecture** for the entire industry and research community.
- Autonomie is highly **customizable**, **flexible** and **adaptable** to the specific needs of the user



Autonomie Comes with a Large Public Database

- Plant models
- Vehicle level controllers
- Powertrain configurations
- Systems and vehicle templates
- Pre- and post-processing scripts
- Processes: drive cycles, standard procedures, performance/acceleration
- Analysis tools: pre-defined plots, reports, summary tables



Allows to Quickly Simulate and Analyze a Broad Range of Advanced Powertrains

Autonomie Provides a Standardized Modeling Environment

- Each elementary piece of a simulation, from definition to analysis corresponds to a set of files: model, initialization, pre-/post-processing script, process, plots, reports.
- Each of those files can be modified **individually**, and can be **reused** in various systems
- Common nomenclature and naming convention
- Simulink models follow common set of rules (I/O, parameterization, etc.)
- Model compatibility checked
- Select simulation outputs to Workspace



***Reduces Duplicate modeling and Analysis work,
Efficient Data Management and Maximum Reusability***



Autonomie Is Highly Customizable

- Provides complete user customization by an **open architecture**
- **Code neutrality:**
 - Users can easily add their own legacy models in Simulink
 - Linkage with other tools: Amesim, GT Power, CarSim
- **Flexibility** to the user specific needs:
 - New configuration can be added
 - Number of levels of complexity (i.e. number of subsystem layers) is not limited
 - Specific processes
- Autonomie can be used for **Component-in-the-Loop, Software-in-the-Loop, Hardware-in-the-Loop...**
- Autonomie simulates from single components, subsystems to entire vehicles (e.g. battery charge/discharge procedure)



Autonomie can be used at various steps in the model-based design process

