Fig. 2 - Offshore wind turbines

Helping engineers in the Green Technology industry overcome their design challenges

The Green Technology Industry poses many different challenges for engineers. From meeting environmental requirements while producing power, to achieving predictable power output despite the numerous variables and unpredictable changes; from optimizing power generation and reducing development risks in energy management projects, to designing multi-domain systems such as Electric Vehicles and adapting quickly to system changes, each field has unique issues.

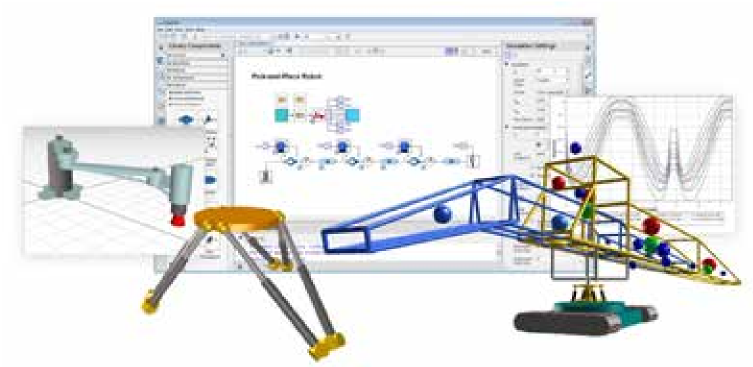

Fig. 1 - Maple and MapleSim allow engineers to successfully address systems design challenges

MapleSim provides an answer to these challenges. It allows engineers to easily create multi-domain systems models and then verify that these models meet their requirements. It enables the engineers to optimize the performance of these models and to seamlessly integrate them with system engineering and multi-objective optimization solutions. In addition, Maple's cutting-edge symbolic calculus solver is able to run complex model simulations extremely fast.

MapleSim allows engineers to:

- quickly develop accurate virtual prototypes to predict system performance at early design stages;
- integrate multiple domains in the same system model (mechanics, hydraulics, electrical, controls, etc.);
- create a virtual model of a physical system directly from its CAD representation and easily characterize it;
- optimize system performance through high-fidelity models;
- easily apply advanced analytical tools to help identify solutions to complex problems.

What follows are the highlights of a few MapleSim case studies that involve multi-domain integration and optimization.

Wind turbine and power generation modeling and optimization

Fast becoming a major source of power around the world, wind power generation looks ever more promising in terms of supply stability, environmental suitability, and safety. The Global Wind Energy Council has a strong outlook for wind power and

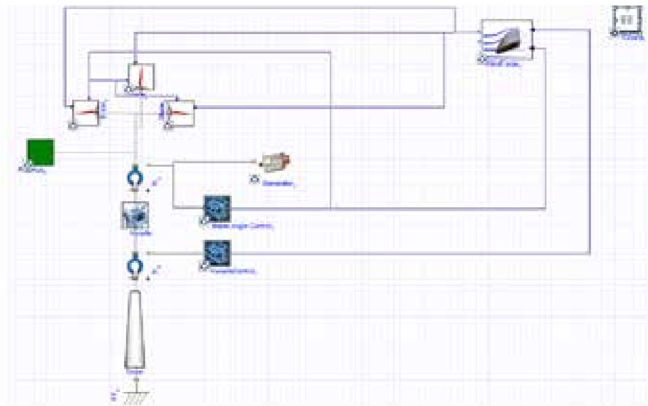

Fig. 3 - Wind turbine model in MapleSim

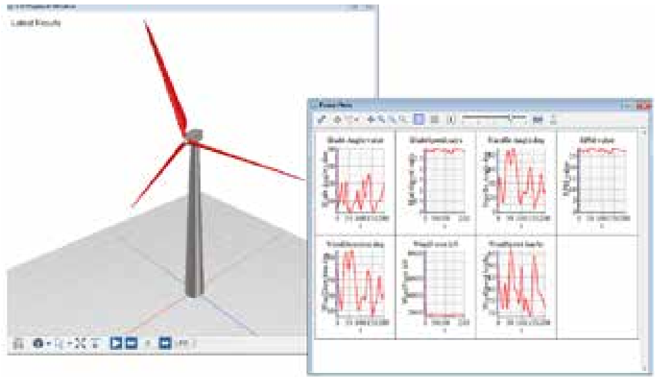

Fig. 4 - Wind turbine 3D model and outputs

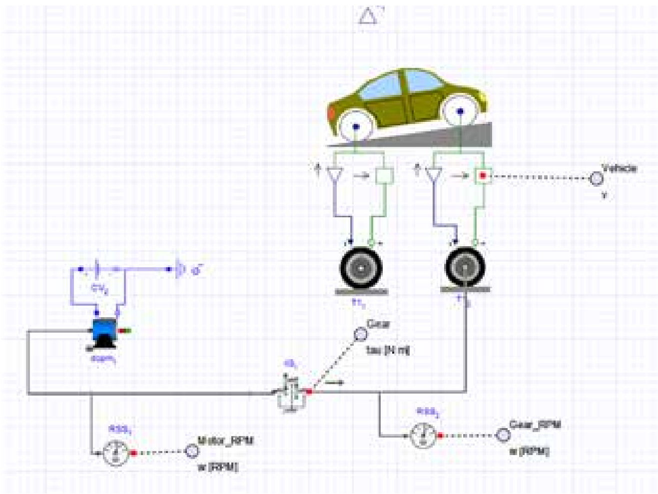

Fig. 5 - A simple Electric Vehicle model

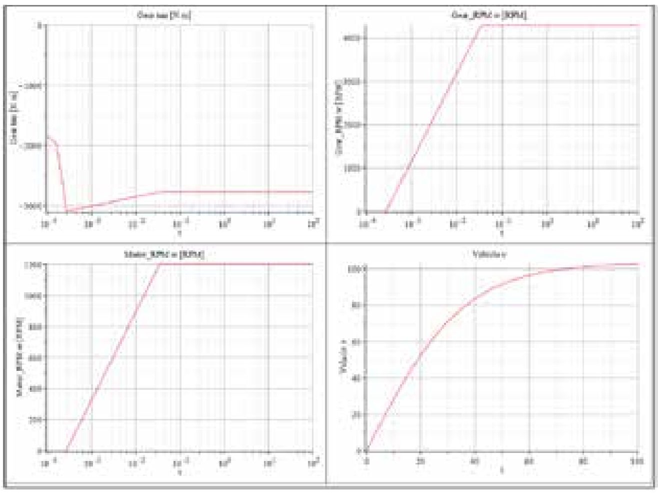

Fig. 6 - EV model outputs

predicts a global installed capacity of over 800GW by 2021. Growing demand for reliable, cost-effective and environmentally friendly generation systems along with strict government norms to reduce greenhouse gas emissions are the driving forces behind the wind energy market growth. Wind turbine manufacturers and energy providers are now focusing their research and development efforts to ensure the reliability for installation environments and to offer highly cost-effective wind turbines. This is particularly necessary for off-shore wind farms in coastal waters where the environment is more demanding, and maintenance or repairs are more difficult and costly. This has led to the development of specific turbine models for offshore wind farms.

This case study focuses on turbine power generation. The implemented model simulates the power generated as wind passes over the blades. The goal was to stabilize power generation by controlling the nacelle and blade pitch angle. This was done by using a DC motor to align the nacelle in the wind direction, as well as by controlling the angle of attack by rotating the blades to reduce the induced drag. The mechanical power generated is converted to electrical power using a DC permanent magnet motor as a generator.

A more stable energy supply provides benefits wind farm operators which are then aple to increase the quality of their power supply quality and decrease their reliability costs.

Electric vehicle system engineering

New-generation electric and hybrid-electric vehicles (HEV) present significant challenges to automotive engineers. The complex multidomain systems involved must be modeled in a single environment, so that design and optimization can be carried out at a system level. MapleSim allows engineers to develop multidisciplinary models to expose the underlying complex interactions between systems, determine component sizing, achieve higher fuel efficiency, and then validate by means of hardware-in-the-loop testing.

As a first example, a model has been developed of a multi-domain vehicle starting from the simple electric vehicle (EV) specifications (such as vehicle curb mass, aerodynamic drag coefficient, gearbox efficiency, etc.) and the selected motor specifications (i.e. provided as a specific motor τ - ω curve) This EV model includes 1-D Mechanical and Driveline MapleSim libraries.

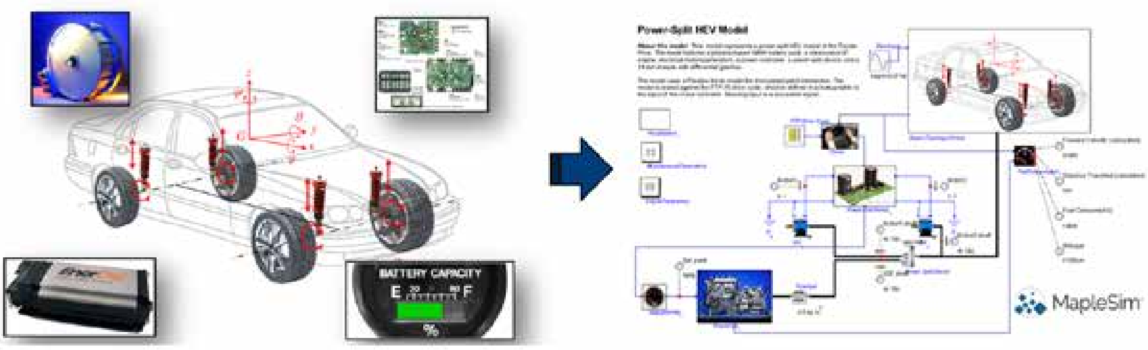

Fig. 7 - An example of a multi-domain HEV system in MapleSim

info@enginsoftusa.com
www.enginsoftusa.com

Fig. 8 - MapleSim Fleet Forward for EV fleet management

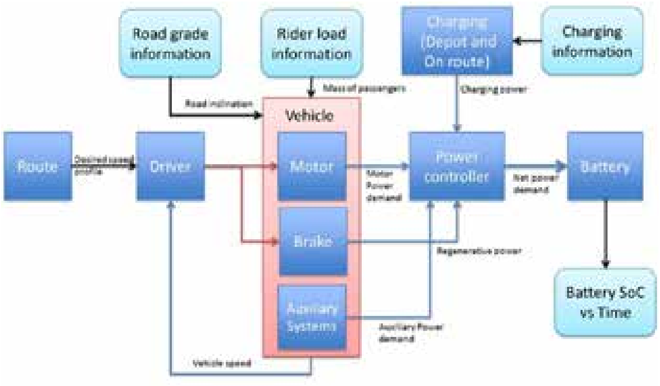

Fig. 9 - Components of a typical electric bus transit environment

Fig. 10 - A small part of NRC's analysis tools is this overlay plotting window

Once this model was parameterized, an analysis could be performed to find out the effect of the gear ratios and calculate whether the motor satisfies the constraints for the maximum slope rate that can be achieved by the EV.

Such simple models can easily be further expanded to describe complex systems and manage multiple design requirements. Furthermore, they can be integrated with Model-Based System Engineering (MBSE) tools which allow for efficient design verification and validation against multiple requirements, throughout the development process.

MapleSim Fleet Forward: a solution for EV fleet management

With concerns for carbon emissions becoming a critical issue, it is increasingly important to transport more commuters using public transit while simultaneously decreasing the environmental impact of these operations. This requires the implementation of new vehicle technologies into existing fleets, which can introduce a host of risks if undertaken without the proper research and analysis.

The National Research Council of Canada (NRC), partnering with Maplesoft, has taken a leadership role in the research of vehicle fleet performance in cities across Canada. With an initial focus on the electrification of public transit, the NRC and Maplesoft developed a comprehensive, model-based tool to simulate the performance of an electric bus fleet in a given city. The purpose of developing the model was to help transit authorities better understand the operational impacts of integrating this new electrification technology into their current fleets without disrupting ongoing operations.

Together, the NRC and Maplesoft have developed MapleSim Fleet Forward, a tool for model-based decisions in transit electrification. The tool plays a central role in the NRC's Fleet Forward Methodology -- a methodology developed and used by the NRC to reduce the risk of deploying battery-electric buses across Canadian municipalities. By incorporating bus configurations, routing information, and a variety of other design parameters, the NRC is able to determine the suitability of a specific route for electrification. This level of detail enables them to define the requirements for particular bus configurations and charging options, ensuring that the investigating transit authority is well prepared for any operational challenges. MapleSim Fleet Forward has established itself as a tool that will help inform operators, equipment manufacturers and regulators, while at the same time improve public transit as a whole.

Conclusion

MapleSim provides a user-friendly environment for the design and simulation of multi-domain systems. Thanks to these features and its comprehensive component libraries, MapleSim lets green technology engineers accelerate their product development by customizing software models for batteries, full electric and hybrid electric vehicles, renewable energy generation, etc. MapleSim models are optimized for speed and accuracy and therefore can be seamlessly integrated with System Engineering and Multi-Objective Optimization solutions for design verification and increased performance.

For more information, contact:
Giovanni Borzi - EnginSoft
g.borzi@enginsoft.com