USER STORY

Electrodynamics Associates Designs High-Performance Generator Controller for the Military with Simulink and xPC Target

Research and development projects for military applications are challenging because of their complexity and innovative nature. For small to mid-size engineering firms to compete successfully for these projects, they must adopt practices that accelerate design and development while solving difficult engineering problems.

Electrodynamics Associates, a designer and manufacturer of electric motors, generators, and associated controllers, met the strict performance requirements for a 200 KW generator for the military by using MathWorks tools instead of building hardware prototypes.

"We used to build hardware-based controllers that were inflexible," explains Jay Vaidya, president of Electrodynamics Associates. "With MathWorks tools, we can run simulations and generate code for a PC or DSP that we place in the control loop. We couldn't have completed this project without them."

High-performance generator controller.

THE CHALLENGE

Electrodynamics Associates would need to design a 200 KW generator capable of running at 62,000 RPM in an airborne system. Since the generator would be used for military purposes, they would need to design the generator and controls to comply with rigid standards and specifications.

The most difficult technical challenge would be to control the conditions and actions of the rotating components inside the generator so that the power generated would meet those specifications. To control these conditions and actions, Electrodynamics Associates would need to simplify complex computations using a mathematical coordinate system of transformations.

"Not only do we want to control the voltage and other conditions inside the generator, but we also want to monitor the data on the machine—speed, current, voltages, and temperatures—from our PC," says Vaidya. "Some of the generator outputs will feed into sensitive avionic equipment, so controlling the voltage is critical."

Finally, Electrodynamics Associates would need to deliver their controller design on a portable system so that military personnel could connect to the generator and validate performance.

THE SOLUTION

Using MathWorks tools, Electrodynamics Associates designed a controller for the 200 KW generator that operates at 62,000 RPM for a military airborne application.

After defining the technical specifications, Vaidya and his team used MATLAB® and Simulink® to model the generator and the power electronics system and to design the control loop. Before they built the generator, they ran simulations of their models to simulate the operation of the generator and validate performance.

THE CHALLENGE

To design a 200 KW generator capable of achieving 62,000 RPM

THE SOLUTION

Use MathWorks tools to model the generator, the power electronics system, and the control loop and provide real-time control for laboratory tests and the customer deliverable

THE RESULTS

- Costly hardware prototypes avoided
- Project deadlines met with automatically generated code
- Future development time reduced with reusable models

> *Other tools only allowed us to view certain parameters of the machine. Now, we can look at all of them. MathWorks tools are orders of magnitude better than any other tool on the market.*
>
> **Jay Vaidya, Electrodynamics Associates**

While the physical system is constructed to provide three-phase power output, the mathematics that describe the current and voltage generation is complex and difficult to implement. Electrodynamics Associates simplified the mathematics with Simulink by expressing the current and voltage generation in a rotating frame of reference.

"The conversion from the three-phase model is too complex for other software packages," says Vaidya. "Simulink let us make these conversions easily."

Using Simulink, Electrodynamics Associates identified the quantities of voltage and current in the rotating frame. Using that data, they controlled the output voltage of the generator. They also modeled the system failure modes and the actions to protect the system in the event of failure.

After completing the preliminary design, mechanical and electrical engineers built the actual generator along with the power electronic devices and control interfaces.

They then used Real-Time Workshop® to generate C code from the Simulink controller model, which they downloaded to xPC Target™ to control their machine. They then tuned and calibrated the controller for generator characteristics.

"There are certain parameters that you cannot measure, such as those that change with temperature," says Vaidya. "You need to estimate parameters in the design stage and then run the machine to tune the controller. This can be a slow process, but xPC Target lets us do it quickly."

Electrodynamics Associates will deliver its design to the military on a CD that contains all of the Simulink models, along with a PC and other hardware to run the system in real time using xPC Target.

The company is incorporating DSP-based controllers, and plans to deploy code onto their new real-time controller for TI's C2000™ and C6000™ DSPs using Target Support Package™ TC2 and Target Support Package™ TC6.

THE RESULTS

- **Costly hardware prototypes avoided.** "We used to build the controllers with resistors, capacitors, and chips, which was expensive because it took a long time to make changes," says Vaidya. "xPC Target lets us make a change by essentially typing in a number."

- **Project deadlines met with automatically generated code.** "We couldn't have completed the project without Real-Time Workshop," says Ottman Elkhomri, an electrical engineer at Electrodynamics Associates. "Our models are so complex that we wouldn't think of writing the code by hand, plus the error messages ease our debugging."

- **Future development time reduced with reusable models.** Electrodynamics Associates is already reusing the models from this project for a 30 KW generator. "We're using essentially the same models, except that we change the numbers," says Vaidya. "That alone will save us 80-100 hours in development time."

To learn more about Electrodynamics Associates, visit *www.electrodynamics.net*

APPLICATION AREAS

- Automatic code generation
- Control design automation
- Industrial equipment and machinery
- Model-Based Design
- Simulation

PRODUCTS USED

- MATLAB®
- Simulink®
- Real-Time Workshop®
- xPC Target™
- Target Support Package™ TC2
- Target Support Package™ TC6

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