

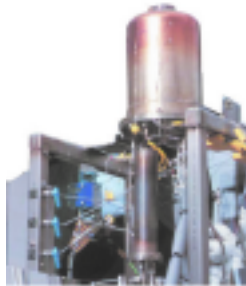
## DEVELOPING AND TESTING EMBEDDED SYSTEMS

Companies use MathWorks products throughout embedded system development—from system design to implementation to test and verification. Applying Model-Based Design with MATLAB® and Simulink® enables engineers to simulate and generate code for production embedded systems, rapid prototyping systems, and test systems. Simulink also serves as a virtual testbed to verify software and hardware implementations through simulation with plant or environment models. MATLAB enables embedded system analysis and optimization by providing tight integration with development tools, calibration systems, and test instrumentation.

### Minimizing Energy Consumption of Hydrogen Generators

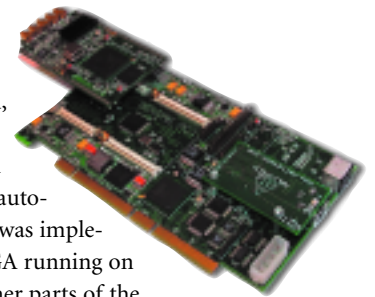
Chess Embedded Technology in the Netherlands developed an embedded controller for a hydrogen generator that acts as a combined power and heat generation system for use in the home.

Commissioned by HydrogenSource, a joint partnership of UTC Fuel Cells and Shell, Chess used MathWorks tools to model, simulate, and generate software for the controller. Using MATLAB, Chess developed a GUI-based application that enables the HydrogenSource scientists to generate and modify embedded software for their dedicated hardware modules without writing C code manually. The application uses Simulink to describe the control algorithms, Stateflow® to define the startup and shutdown behavior, and Real-Time Workshop® Embedded Coder to automatically generate code. The generator is expected to reduce energy consumption by 25%, significantly lowering CO<sub>2</sub> emissions. [www.chess.nl](http://www.chess.nl)

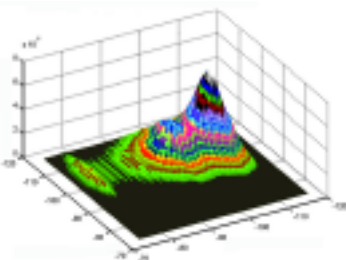


### Developing an FPGA-based Video Encryption System

Nallatech in the United Kingdom used MathWorks and Xilinx tools to develop a reconfigurable video encryption system for the UK Ministry of Defence, enabling their engineers to change algorithms on the FPGA without needing to learn VHDL. Nallatech also demonstrated how to reverify the entire system more quickly by performing validation at a sub-system level. Engineers developed, tested, and debugged the encryption algorithms in Simulink, then used Xilinx System Generator to automatically generate VHDL, which was implemented on a Xilinx Virtex-II FPGA running on Nallatech's BenAdda module. Other parts of the Simulink model served as a test harness. The development took one-third of the time it would have taken to write the VHDL manually. [www.nallatech.com](http://www.nallatech.com)



### Identifying Noise and Other Interference on Communication Links



YarCom implemented a stimulus-response test system to identify and locate noise and other interference on communication links in remote locations. YarCom used the Data Acquisition and Instrument Control toolboxes to acquire data

in the IF, AF, and RF spectrum ranges using remotely placed instruments, with the stimulus controlled by MATLAB serial port commands. Using the Communications, Statistics, and Signal Processing toolboxes, engineers analyzed the collected data and identified interference. The Mapping Toolbox helped them analyze the results in a geographic context and locate sources of interference. As a result, Yarcom can identify and resolve noise and interference problems in hours. [www.yarcom.com](http://www.yarcom.com)

### Teaching Digital Signal Processing to Undergraduates

Clarkson University introduces freshman engineering students to MATLAB and Simulink as core tools for their undergraduate studies. This early exposure enables instructors of subsequent courses to focus on course topics and theories, combined with hands-on examples and exercises. For example, in the senior-level digital signal processing course, students learn topics such as



Fourier series, digital filters, and spectral estimation. They also learn to build real-world DSP applications by designing algorithms in Simulink and using Real-Time Workshop to generate embedded code for TI C6000™ DSP chips. This combination of theory and hands-on experience gives students the background and skills they need to tackle real-world engineering problems. [www.clarkson.edu](http://www.clarkson.edu)

## Designing Control Schemes for a Next-Generation Washing Machine



Whirlpool Corporation is replacing a paper-driven design process with Model-Based Design to develop advanced control algorithms for the Whirlpool® Duet HT® washing machine. Using this approach, Whirlpool models the behavior of a washing machine with MATLAB and Simulink, then designs control schemes for different wash sequences and set combinations. Hardware interconnections are specified using target-specific I/O blocks in the model. Once the control schemes are tested through simulation, the engineers use Real-Time Workshop to generate the control code, which they download to an xPC TargetBox™ connected to the washing machine's motor, to verify the controller performance with the production equipment. [www.whirlpool.com](http://www.whirlpool.com)

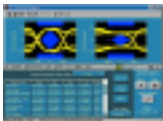
## Creating Automotive Embedded Software Using a General-Purpose Prototyping ECU

Jaguar uses MathWorks products and add2's Microgen electronic control unit (ECU) to develop embedded software for automotive transmission, driver entertainment, and body systems. The Microgen ECU, based on the Motorola® MPC555 microcontroller, provides a flexible prototyping target that is architecturally similar to the production ECU. In a typical project, engineers design their algorithms in Simulink and Stateflow, modeling the I/O using Simulink blocks from the Embedded Target for Motorola MPC555 and from add2. After validating their algorithms in simulation, they use Real-Time Workshop to automatically generate C code. Test engineers then download the code over CAN bus into RAM or flash memory on the target ECU. By testing the new features on real hardware, Jaguar improves the quality of specifications that they provide to their suppliers. [www.jaguar.com](http://www.jaguar.com)



## Delivering a Compliance Test System Using MATLAB on an Oscilloscope

Tektronix uses MathWorks products to develop and deploy compliance and analysis test solutions for PCI-Express™, InfiniBand®, and other high-speed serial I/O technologies in the computing and communications industries. Tektronix RT-Eye™ software uses MATLAB as its analysis and plotting engine for waveform eye diagrams, histograms, trend plots, and jitter bathtub curves. The measurement and analysis features in RT-Eye, which runs on the Tektronix TDS6000B and TDS/CSA7000B high-performance oscilloscopes, enable hardware designers and validation engineers to reduce time to market of their next-generation system designs. [www.tektronix.com](http://www.tektronix.com)



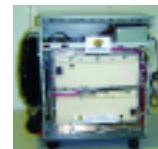
## Controlling Unmanned Aerial Vehicles

BAE SYSTEMS Platform Solutions integrated MathWorks products with their CsLEOS™ real-time operating system on several manned and unmanned aircraft programs, including the integrated vehicle management system on the Northrop Grumman Pegasus X-47A. They used MATLAB, Simulink, and Stateflow models to simulate unmanned aerial vehicle system behavior and to design components that supported autopilot and integrated navigation operation. They specified the RTOS mapping using Simulink blocks, then automatically generated flight code with Real-Time Workshop Embedded Coder to

run on the embedded controllers under CsLEOS. This approach enabled them to design and test entire applications as models, and then rapidly implement them on the target system. [www.csleos.com](http://www.csleos.com)

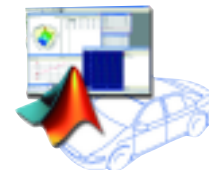
## Developing and Debugging TI DSP Software for Power Generator Controllers

Electrodynamics Associates uses MathWorks tools to design and debug TI DSP software for their 30 KW generator controller. Their engineers model the system in Simulink, then automatically generate optimized code for the TI C6711 chip using Real-Time Workshop and the Embedded Target for TI C6000™. The Link for Code Composer Studio™ Development Tools uses the JTAG Emulator and Real-Time Data Exchange capabilities to facilitate code debugging and validation, measure the time consumed while running on the DSP, monitor variables, and display currents and voltages from the chip in real time. [www.electrodynamics.net](http://www.electrodynamics.net)



## Auto-Calibrating Embedded Algorithms on Automotive Production ECUs

Bosch Diesel Systems has demonstrated how INCA and MATLAB can be used together as a time-saving calibration system for vehicle ECUs. MATLAB scripts are used to “drive” the engine to a certain operating point at predefined conditions. MATLAB scripts then change parameters of selected controllers to determine their stability criteria, using the MATLAB API of the INCA Measurement and Calibration System from ETAS to access parameters and measurements. The resulting data is then analyzed in MATLAB using Fourier transforms and the Ziegler-Nichols method to compute new calibration values for the ECU's software, which INCA then writes into the ECU memory. This combination of MATLAB and INCA performs automated calibrations within half the time previously needed and thus helps to meet the tight timelines of modern ECU development projects. [www.bosch.com](http://www.bosch.com)



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