Q&A: The Impact of NI LabVIEW 8.5 on Machine Builders

Brian MacCleery, NI senior product manager, discusses how National Instruments LabVIEW as well as multicore and FPGA technologies are impacting machine builders and the growing mechatronics segment.

Q: What benefit does multicore processing offer machine builders?

MacCleery: Over the last few years, chip vendors including Intel and AMD have adopted multicore processor architectures to overcome the heat dissipation and power consumption challenges inherent when increasing clock speeds. The parallel architecture of multicore processors presents an opportunity for machine builders to use off-the-shelf embedded multicore systems to achieve faster loop rates and process a greater number of input stimulus signals.

Q: How does LabVIEW 8.5 impact machine builders?

MacCleery: LabVIEW 8.5 and the LabVIEW Real-Time Module introduce symmetric multiprocessing (SMP) support for embedded real-time systems. Designers must consider how their software can take advantage of SMP and multicore processors to achieve greater performance while maintaining the deterministic execution critical in real-time systems.

This includes applying fundamental concepts such as multithreaded and parallel programming, optimization techniques including data parallelism and pipelining and advanced concepts such as dedicating specific cores of processors for different tasks in a real-time embedded system. The latest version of LabVIEW extends the multithreading support of graphical programming on desktop systems to embedded real-time applications.

In addition, LabVIEW 8.5 introduces the LabVIEW Statechart Module. With this tool, designers can overcome the limitations of traditional state machines such as the inability to represent concurrently executing states, which are essential to manage safety shutdown scenarios. With the higher-level system representation provided with statecharts, the design process can also be accelerated. Today there are software tools available for designers to not only model their machine control systems with statecharts but also create executable code that implements their machine logic onto desktop, embedded real-time and FPGA-based hardware platforms. This ability to use one software tool to both design and implement a machine control system should shorten the time needed to create a functioning machine control system.

Q: How common is embedded design among machine builders?

MacCleery: Machine builders design a very broad segment of machines including everything from traditional machines such as packaging and biomedical machines, to consumer interfacing machines such as soft drink dispensing, to high-end machines for applications such as physics experimentation. Certainly the more traditional machines with straightforward requirements are frequently designed using programmable logic controllers (PLCs). However, mechatronics systems, high-volume deployments and systems that require sophisticated measurements and analysis frequently require more flexibility or lower price points than a PLC can provide. This forces some machine builders to design their own hardware and employ embedded design processes.

National Instruments recently surveyed 30 companies to understand machine builders' needs and found that 23 of the 30 companies had to build their own hardware for requirements including custom signal conditioning, custom signal processing and high-speed control. To be candid, these results may

not be typical of all machine builders because more than half of those companies were NI customers. Many machine builders select our products because of the flexibility of our FPGA-enabled programmable automation controllers (PACs) and the ability of our PACs to replace custom hardware, so our unique capabilities may have affected the results.

Q: What is the potential for using FPGAs in machine design?

MacCleery: FPGAs are huge fields of programmable gates that can be programmed into many parallel hardware paths. With multicore processors and FPGAs working together in a hybrid SMP configuration, you can achieve extreme performance and reliability. For instance, on a part-handling machine, you could program one core to focus exclusively on high-speed motion control and another core to handle other processes such as HMI and industrial communication. Along with these two parallel processes, in the same LabVIEW Project, you could configure an FPGA to continually monitor the vibration amplitudes and frequencies on your motors for predictive maintenance and general safety.

LabVIEW 8.5 introduces new multichannel PID in the LabVIEW FPGA Module to give machine builders the ability to design optimized high-channel-count systems. They can further differentiate their machines by making use of new IP blocks such as notch and Butterworth filters to design custom control algorithms. Along with dual-core processors, FPGAs further increase the processing capabilities of machines by acting as multicore processors themselves.

Q: How does LabVIEW 8.5 support the field of mechatronics?

MacCleery: Over the years, LabVIEW has evolved from a test and measurement package, constantly expanding into areas such as mechanical, electrical, embedded and control design.

First, **mechanical design** is one of the primary building blocks for mechatronics. National Instruments, in collaboration with SolidWorks, has developed the NI LabVIEW-SolidWorks Mechatronics Toolkit. This toolkit is designed to help develop complex multiaxis motion profiles, detect collisions and simulate the mechanical dynamics for machines.

The second area is **electrical design.** Machine builders are always looking for ways to improve their electrical designs. The combination of LabVIEW with NI Electronics Workbench Group Multisim software gives engineers the ability to close the hardware design loop. It provides designers with input and feedback never before available, so they can efficiently test and verify both their circuits and simulations. LabVIEW contains VIs that interface with Multisim to import/export Multisim data as well as resample them.

Control design is also an important component**.** The new multichannel PID in the LabVIEW 8.5 FPGA Module gives machine builders the ability to design optimized high-channel-count systems. Engineers can further differentiate their machines by making use of new IP blocks such as notch and Butterworth filters to design custom control algorithms. Along with dual-core processors, FPGAs further increase the processing capabilities of machines by acting as multicore processors themselves.

Finally, **embedded design** is another critical element**.** With the new LabVIEW 8.5 Statechart Module based on the Unified Modeling Language (UML) standard, engineers can quickly model their embedded systems to run on real-time operating systems, FPGAs, PDAs and touch panel computers. Engineers can take advantage of the open architecture of LabVIEW to integrate their machines with new and existing systems using OPC, Modbus, PROFIBUS and DeviceNet and develop sophisticated HMI/SCADA systems to monitor real-time data and log historical information to databases and enterprise resource planning (ERP) systems.

Q: What does graphical system design mean for machine builders?

MacCleery: For years, NI has evangelized virtual instrumentation, a concept that has revolutionized the industry. Virtual instrumentation makes it easy for engineers to create user-defined systems that meet their exact application needs. Graphical system design with LabVIEW extends virtual instrumentation, giving designers a single platform to tackle their measurement, analysis, connectivity and control challenges. Graphical system design combines high-level development tools, such as statecharts, with the ability to deploy machine control systems to the desktop.

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