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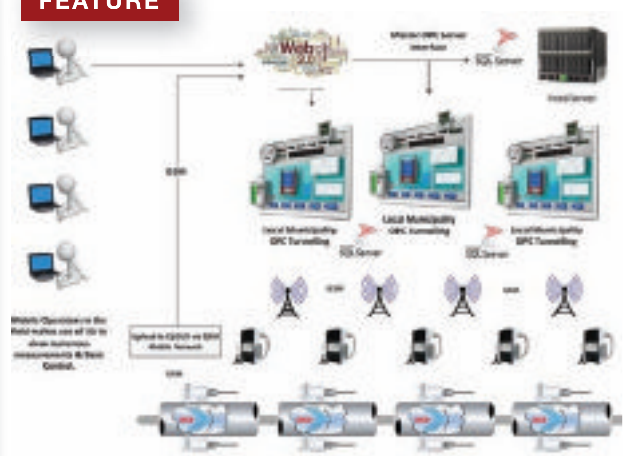

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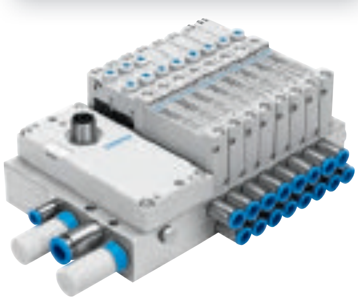

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THINK AGAIN

Control engineering secrets

If there were a state of Control Engineering, everything in that state would be top secret. Here's why.

Effective applications of control engineering, automation, or instrumentation technologies produce results so startling that, even if the end user or machine builder is willing to talk about the project at all, we very often hear: "We don't want our name mentioned because we don't want our competitors to find out." If there were a state of Control Engineering, everything in that state would be classified as top secret.

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Great part is, none of these are secret either, and we have an ever-growing contingent of experts contributing to Content for Engineers.

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Mark T. Hoske,
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CONTROL ENGINEERING
1111 W. 22nd St. Suite 250, Oak Brook, IL 60523
630-571-4070, Fax 630-214-4504

Content Specialists/Editorial

Mark T. Hoske, Content Manager
630-571-4070, x2214, MHoske@CFEMedia.com

Peter Welander, Content Manager
630-571-4070, x2213, PWelander@CFEMedia.com

Patrick Lynch, Project Manager/Engineers' Choice
630-571-4070, x2210, PLynch@CFEMedia.com

Bob Vavra, Content Manager
630-571-4070, x2212, BVavra@CFEMedia.com

Amara Rozgus, Content Manager
630-571-4070, x2211, ARozgus@CFEMedia.com

Amanda McLeman, Project Manager
630-571-4070, x2209, AMcleman@CFEMedia.com

Chris Vavra, Content Specialist
630-571-4070, x2219, CVavra@CFEMedia.com

Brandon Marcellis, Content Specialist
BMarcellis@CFEMedia.com

Contributing Content Specialists

Frank J. Bartos, P.E.,
braunbart@sbcglobal.net

Jeanine Katzel jkatzel@sbcglobal.net

Vance VanDoren Ph.D., P.E.,
controleng@msn.com

Suzanne Gill, European Editor
suzanne.gill@imlgroup.co.uk

Michael Majchrzak, Control Engineering Russia
mike_majchrzak@trademedia.us

Katarzyna Jakubek, Poland Editor-in-Chief
kj@utrzymanieruchu.pl

Milan Katrusak, Czech Editor-in-Chief
mk@controlengcesko.com

Andy Zhu, Control Engineering China
andyzhu@cechina.cn

Publication Services

Jim Langhenry, Co-Founder/Publisher, CFE Media
630-571-4070, x2203; JLanghenry@CFEMedia.com

Steve Rourke, Co-Founder, CFE Media
630-571-4070, x2204, SRourke@CFEMedia.com

Trudy Kelly, Executive Assistant,
630-571-4070, x2205, TKelly@CFEMedia.com

Elena Moeller-Younger, Marketing Manager
630-571-4070, x2215; EMYounger@CFEMedia.com

Michael Smith, Creative Director
630-779-8910, MSmith@CFEMedia.com

Paul Brouch, Web Production Manager
630-571-4070, x2208, PBrouch@CFEMedia.com

Michael Rotz, Print Production Manager
717-766-0211 x4207, Fax: 717-506-7238
mike.rotz@frycomm.com

Maria Bartell, Account Director, U.S. Sales
630-288-8310; mbartell@mardevdm2.com

Rick Ellis, Audience Management Director
Phone: 303-246-1250; REllis@CFEMedia.com

Letters to the editor
Please e-mail us your opinions to MHoske@CFEMedia.com or fax us at 630-214-4504. Letters should include name, company, and address, and may be edited for space and clarity.

Information
For a Media Kit or Editorial Calendar, email Trudy Kelly at TKelly@CFEMedia.com.

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Publication Sales

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248-538-8804 BHoffman@CFEMedia.com

Bailey Rice, Midwest
630-571-4070 x2206 BRice@CFEMedia.com

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858-270-3753 ISeibert@CFEMedia.com

Julie Timbol, East Coast
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Monitor machine conditions

Machine condition monitoring can be integrated within digital control of permanent magnet synchronous motors (PMSM).

Krzysztof Pietrusewicz, Paweł Waszczuk

Modern digital servo drives differ from simple ac motor drives used in control of asynchronous motors in many ways. Servo drive features include advanced regulation algorithms, complex methods of trajectory generation, programming drive applications according to the PLCopen Motion Control standard, and addition of Safety Integrity Level. Also, deterministic Ethernet communication protocols are more widely used for multi-axis systems and complex synchronized machine motion control.

■ Integrated servo drive condition monitoring: A prior article [Diagnostics for machine tool monitoring, Krzysztof Pietrusewicz, Nov. 23, 2011, CE USA] presents a concept to integrate diagnostic functions based on mechanical vibrations and vibro-acoustic measurements in digital servo drives controlling a computer numerical control (CNC) feed-drive unit. A laboratory stand demonstrated the concepts according to the mechatronic assumptions of industrial target systems.

■ Prototyping regulation algorithms: Mechatronic design is considered among techniques allowing time reduction related to implementing new regulation algorithms concepts in industrial applications.

Software-in-the-loop applications are prototyping simulations, prepared on a designer's computer to model the behavior of a real-time control system.

Figure 1 shows how, from the kick-off (KO) of the project to the final (M7) milestone, there are four main cycles in the typical scientific approach for rapid prototyping (1). By excluding the so-called virtual prototyping (2), the project can be finished more quickly. With tools for on-target prototyping (Pietrusewicz K. and Urbański Ł., "Balancing PLCs, PACs and IPCs: What controller fits your application?" CE, Jan., 2011, pp. 28-32), the project can be finished before M4.

■ Virtual prototyping allows a regulator (algorithm) placed in a real-time controller to communicate using an automatic program code generator via TCP/IP, TCP/UDP, or OPC DA protocols with a simulated (virtual) object, and its behavior is emulated by a special application on the designer's computer.

■ Hardware-in-the-loop is a technique based on testing functionality of the prototyped regulation algorithm along with

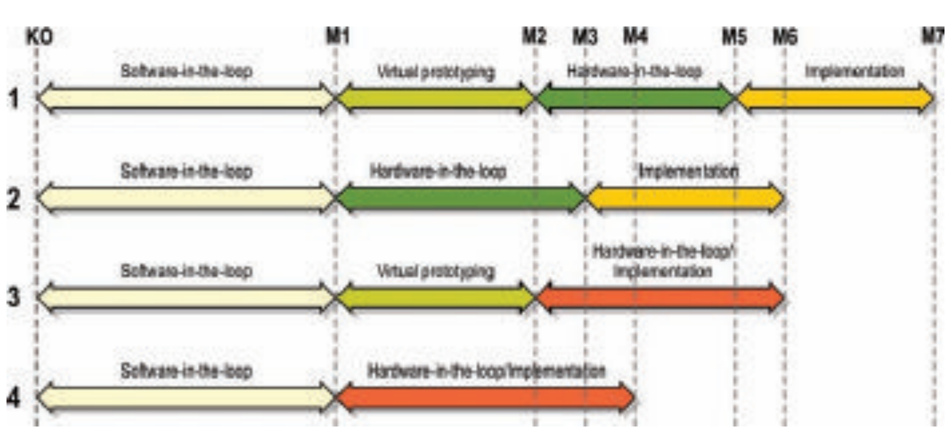

Figure 1: From start to finish, there are four main cycles of rapid prototyping (1). Excluding virtual prototyping (2), the project can be finished more quickly. Courtesy: West Pomeranian University of Technology, Szczecin, and Control Engineering Poland

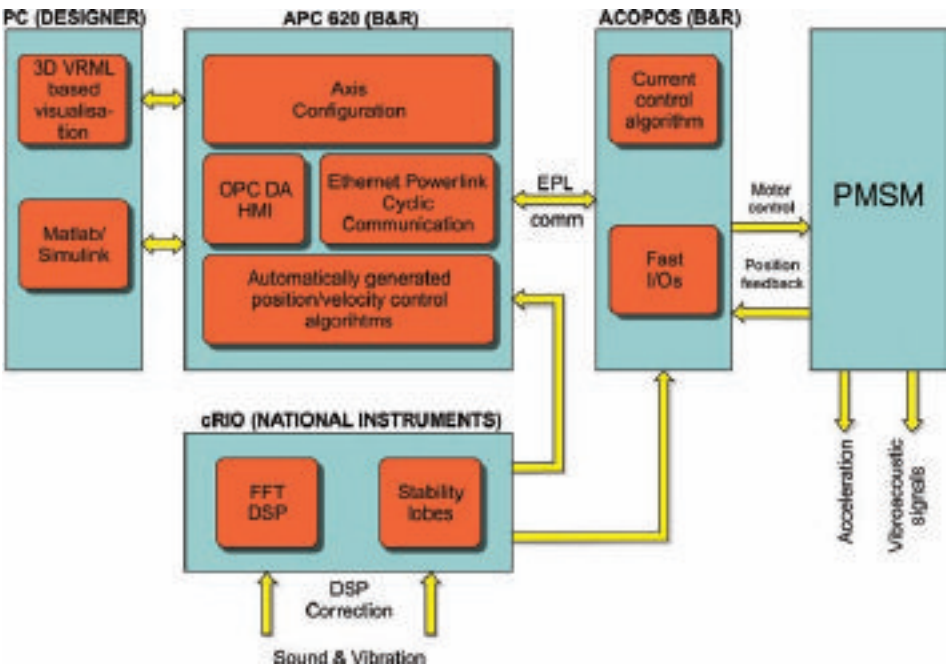

Figure 2: Functional scheme of designed and created laboratory stand. Courtesy: West Pomeranian University of Technology, Szczecin, and Control Engineering Poland

an emulated model of an object by a real-time controlling device. While time-consuming, this method is extremely valuable, mainly due to the possibility of cost-free testing of emergency situations, without any threat of destroying execution elements of the control system.

■ Implementation: The final stage of mechatronic design is enabled with tools like Automation Studio Target for Simulink by Bernecker&Rainer. When using laboratory equipment (such as dSpace DS1104), the implementation stage must be done in the target device, which is additional work, as shown in Figure 1.

A fast prototyping stand for diagnostic functions in a digital PMSM servo drive: The functional scheme for the laboratory stand is shown in Figure 2.

Figure 2 shows the mechatronic on-target prototyping test stand. A multi-vendor approach lets the user integrate functionality of embedded DSP corrections based on FPGA calculations in the National Instruments CompactRIO RT controller with cyclic Ethernet Powerlink communication between Bernecker&Rainer's APC620 industrial computer and Acopos1090 digital servo drive. The Matlab/Simulink environment from MathWorks lets the user automatically generate newly developed position/velocity control algorithms and include them within the cyclic tasks of the real-time operating system (automation run time). With the open OPC DA server technology, users can visualize the 3D X-Y table movement of the milling machine on the computer screen.

Test stand components include:

■ Developer computer with installed Matlab/Simulink 2010b and Automation Studio B&R software

■ High-efficiency real-time system controller, in this case an industrial computer APC620 and servo drive Acopos (both from B&R), working as a cyclic-current-value generator. All performed measurements and data processing are by National Instruments controller NI-9022.

The developed stand enables research in the field of improvement of digital servo drives applications, for example by integrating diagnostic functions with suboptimal position and velocity regulation algorithm or by generating additive torque value transferred to a PMSM motor, depending on diagnosed working conditions. **ce**

- Krzysztof Pietrusewicz and Paweł Waszczuk, West Pomeranian University of Technology, Szczecin, and Control Engineering Poland.

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