INDUSTRIAL NEWSLETTER

MOOG

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# Inaugural Issue

Moog is pleased to provide our first quarterly issue of a special global newsletter for industrial products. Our objective is to regularly provide valuable technical and business updates that will be valuable to our customers and partners. It will be in a brief, convenient format that includes and easy link for more information.

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**Feature Article**
Intelligent Actuation Devices and Distributed Control

# Intelligent Actuation Devices and Distributed Control

## The Machinery Builders' Answer to the Evolving Needs of the Factory Floor

A significant shift in the fundamental architecture of industrial control systems is slowly taking shape. This shift is from a control architecture focused on PCs and PLCs to one featuring intelligent actuation devices and distributed control. The new paradigm is made possible by high-performance actuation devices that embed integrated closed-loop motion control and a high-speed, digital, network capable, bus interface. The underlying technology that enables this trend includes:

- Affordable digital electronics with increasing performance and lower power consumption.
- Innovative industrial-temperature grade actuation device packaging.
- High-speed, deterministic network busses with open-standard communication protocols.
- Object oriented, distributed architecture focused software tools.

### The Hydraulic Injection Molding Machine Example

The hydraulic Injection Molding machine represents a good example of this concept because distributed control offers significant benefits to this application. Figure 1 is a conceptual drawing of a hydraulic Injection Molding machine using a distributed control architecture. A high-speed, digital bus is daisy-chained to each device. For low power devices, such as a servovalve, only one cable, with power included, is required. In the case of higher power devices such as solenoids or in the case of a fiber optic network, a separate power cable is needed. Even then, significant decreases in cabling to remote axes can be realized by using a junction box – outlet approach.

Moog's Motion Control Valves are key components of the distributed architecture of this machine as they offer networked communication, the ability to configure key parameters and real-time monitoring. Axis loop closure and machine sequencing is performed directly at each of Moog's Motion Control Valves without the requirement for a central controller. Sensors measuring position, pressure, temperature and other key parameters are bus enabled, as are other control peripherals such as solenoid valves. The Moog Motion Control Valves poll sensors and command solenoids over the bus at real-time, servo loop update rates. Motion valves communicate peer to peer to synchronize parallel machine movements.

Other network devices include a machine Pendant used for axis tuning, recipe adjustments, manual axis movements, and display. A single PC is able to communicate to all machines on the factory floor. It is a central location for recipe storage and can download setup parameters and control programs to each intelligent node on each machine in the factory. Alarms, diagnostic information and SPC data is logged from intelligent devices on all machines, in conjunction with network enabled tools such as scales, and vision systems.

## Evolving Technologies Central to Distributed Motion Control

Two evolving technologies significant to the growth of distributed motion control devices are network busses and object oriented programming methods and tools. Both are hot topics in the industrial marketplace and academia. Both have experienced enormous innovations in recent years, with the promise of exciting product introductions in the future.

A distributed architecture, digital bus capable of high performance servo control, must possess certain characteristics. The first and most important is deterministic cyclic communication. Synchronous data packet updates of 125 microseconds with sample-to-sample jitter less then one microsecond is a good baseline. This grade of bus performance enables a Motion Control Valve to collect sensor information and close high-performance hydraulic digital servo loops. Non-real-time, asynchronous parameter updates and device programming must also be supported. Some current digital busses that use the synchronous/asynchronous topology at the required speeds are: Profibus DPV3, Firewire, Sercos and a few Ethernet derivatives.

The second key characteristic is that devices on the bus must be able to communicate with each other in a peer-to-peer fashion, without having to first go back through a master PC or PLC. A Publisher-Subscriber architecture [versus a Client-Server architecture] makes this possible. Each device is able to subscribe to the specific data that it wants, which is published by other devices on the bus. Response time delays on the bus are significantly reduced.

The other technology that facilitates distributed motion control is object oriented programming, as this methodology is well matched to control systems composed of distributed, networked devices. Two methods at the forefront are the Unified Modeling Language standard and the IEC61499 Function Block oriented approach. Both modeling languages abstract software and hardware details from a higher-level, allowing a more organized approach to solving complex, distributed control problems. The benefits of this are code reusability and ease of maintainability. In addition, a System Engineer does not have to be involved in detailed device control algorithm development or a programmer to construct a complex system.

IEC61499 provides the means to define the architecture of the entire control system as a set of network connected devices and resources. It builds on the IEC61131-3 ability to encapsulate algorithms to include sub-applications and system applications. IEC61499 also supports a more generalized construct of program execution. In the case of IEC61131, execution of a program is triggered by a periodic or non-periodic task at the central controller. In the distributed architecture case, a central controller is not available to enforce task execution schedules. Each IEC61499 function block has its own event driven execution control, enabling the complete execution of a system to be distributed. System development is carried out on a PC, simulated, and then executables are downloaded to each Motion Control Valve and other programmable device.

Graphical, object oriented programming tools are becoming more widely available. Standards committees exist for both mentioned methods. The IEC61499-1 Architecture Standard is scheduled for completion the end of 2003.

## Benefits of Distributed Control

The benefits of distributed control are many. Some of the most important points are:

- Agile manufacturing systems become a reality. A diverse and quickly changing economy requires frequent changes in manufacturing product mix and volume. Distributed control enables:

- Fast, easy, and robust dynamic reconfiguration of modular machines, going beyond the scope of today's complex software models that use parameterization to achieve flexibility.

- Rapid introduction of new technology.

- Machine builder's costs are lowered. This is due to less cabling, smaller cabinet size, improved documentation, minimal assembly and ease of commissioning.

- Using a digital bus eliminates sensitive analog wiring. Analog signals to valves and sensors are prone to noise and failures and are restrictive in feedback resolution.

- Visibility to the factory floor increases with network enabled components. Operation Managers can obtain accurate information in the form of process data and diagnostic feedback.

- Development cycle times are reduced using object oriented programming methods. Modular systems and software designs enhance software portability and reuse.

All these benefits lead to superior performing machines that can be quickly customized and optimized for each end-user, each factory, each machine and each part setup.

### *About the Author:*

**Daniel Halloran, Controls and Electronics Section Head**
Dan has been with Moog ICD Engineering for the past 5 years. He has 20 years experience in the development of hardware and software for control systems used in industrial and military applications.

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# Hot Websites

### Scirus (www.scirus.com)

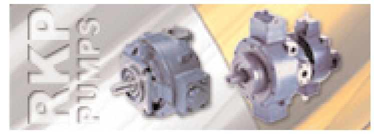
Scirus is the most comprehensive science-specific search engine available on the Internet.
Driven by the latest search engine technology, it enables scientists, students and anyone searching for scientific information to chart and pinpoint data, locate university sites, and find reports and articles quickly and easily.

### eFunda (Business Identification Number Cross-reference System) (www.efunda.com)

eFunda is a premier online publisher for original engineering content and software. They offer over 30,000 pages of engineering fundamentals and calculators, authored exclusively by highly educated and experienced staff to give you the most credible engineering information.

# Product Spotlight

## RKP Pumps




An important addition to Moog's hydraulic products line is the well known RKP Pump. The complete product line was acquired by Moog Inc. February, 2001 and production was recently transferred to a new facility in Nuremburg, Germany. The product was originally developed by Bosch and has served the industrial market for over two decades. The modular nature of the RKP permits customized solutions and the design is characterized by high reliability, low noise levels, and rapid response in a compact package. There is a large selection of manual and electric-hydraulic control (EHV) options, as well as high pressure versions and pumps suitable for special fluids. At the recent Hannover Messe, Moog exhibited a new (EHV-D) version with fieldbus interface.

### Features

- 7 pump sizes between 19 and 140 cm_/ rev.
- Extended warranty 10,000 hours or 24 months (when used with Mineral Oil).
- Maximum speed range: 1,800 to 2,900 rpm.
- Standard design permits continuous pressure to 280 bar [4,000 psi] with 350 bar [5,000 psi] peak limit.
- High pressure version capable of continuous pressures up to 350 bar [5,000 psi] with 420 bar [6,000 psi] peak limit.
- Special versions suitable for operation with HFA, HFB, HFC, and HFD fluids and cutting emulsion.

For more information, click on **RKP Pumps**.

*About the Author:*

**Martyn Waddington, Distribution Manager, Moog Europe.**
Employed by Moog International in a number of engineering and managerial assignments since 1966.

# Ask the Expert

## Cavitation


**What causes cavitation in a hydraulic cylinder application?**
Cavitation results when the cylinder gets vacuum in one or both of the working areas. Typical reasons are high inertia forces and servo or proportional valves that are incorrectly sized. This happens frequently with unequal area cylinders.

**What does cavitation mean for my application?**
A cavitating system results in an erratic control system.

**How can I identify a cavitation problem on my application?**
There are several indications to help identify this problem including: 1. losing O-rings at the valve interface, 2. the achievable controller gain is much less than calculated, 3. the drive gets high over- and undershoots when decelerating. The system configuration has to be changed to avoid cavitation by applying asymmetric valve spools or other similar remedies.

To submit a question, click on **Ask the Expert**.

## Upcoming Events

Please visit the Moog booth at:

- H&P Show in Sao Paulo, Brazil (September 16 - 19, 2003)
- Hydraulic and Pneumatic Fair in Tampere, Finland (September 30 - October 2, 2003 )
- EMO - World Exhibition of Metalworking Milano, Italy (October 21 - 28, 2003)
- Fabtech International 2003 in Chicago, IL, USA (November 16 - 19, 2003) Booth 16142
- PTC Asia 2003 in Shanghai, PRC (November 18 - 21, 2003)
- SPS/IPC Drives in Nurnberg, Germany (November 25-27, 2003)

For more information, click on **Exhibits and Trade Shows**.

## Moog Training Sessions

- Introduction to MACS Moog Axis Control Software/IEC 61131 Programming
  - September 9-11 2003 English
  - September 23-25 2003 German

- Hardware: MSC Moog Servo Controller and Extension modules
  - October 7-8 2003 English
  - October 14-15 German

For more information, click on **Training Opportunities**.

## Contact Us

To find the location or distributor nearest you visit **worldwide locations**.

## E-mail Newsletter

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