Control Engineering, August 1995.

CONTROL ENGINEERING. August 1995 A CAHNERS PUBLICATION

Motion Software Heads Toward Friendlier User Environments

KEVIN HOLLOWAY, Parker Hannifin Corp., Compumotor Division, Rohnert Park, Calif.

Software is the driving force in the motion control market. Here is a survey of what some companies are doing today as they strive towards the future. The 14 companies included in this article are representative suppliers of products or services to the motion control industry. Their technical input formed the basis of this article.

Compumotor's Motion Architect directs the functions of a surface-mount machine at the company's manufacturing facility. The software automatically generates set-up code and also edits and executes motion programs.

Motion control hardware and software for factory automation equipment have developed in significant ways over the past 15 years. The number of companies offering software has grown rapidly. Motion software is a particularly important topic today, since software rather than hardware is driving the market. With some notable exceptions, motion control hardware has entered the commodity stage.

The future direction of motion control software, and thus the options available to the motion engineer, can be viewed by examining the major software types and the nature of motion control companies. Naturally, these companies have different philosophies on how to conduct business, the types of products they want to develop, and their concept of the "right" approach to solve their customers' motion control problems.

Motion control software can be divided into two distinct varieties. The first is the operating system (OS) software that resides in Read Only Memory on motion controllers. This often is referred to as firmware. The second variety comprises motion software and development tools written for personal computers (PCs).

Motion software must cater to non-specialist programmers

Controller operating software

Let's first look at firmware and how it relates to motion control hardware architecture, which in turn is divided into two general categories:

- Products that have a processor (intelligent peripheral) and a proprietary operating system; and
- Products that rely on a host processor for executing motion functions.

In the first category, each controller contains one (or more) processor to control the motors, monitor I/O points, communicate with the operator interface, and execute the motion control commands. There is no need for any external microprocessor. Emerson Electronic Motion Control (Chanhassen, Minn.), Compumotor, and other motion companies design intelligent peripheral controllers that are processor-based.

In short, these specialized "computers" use their internally stored operating system like a PC uses MS-DOS. Each company

that designs this type of motion controller has its own proprietary operating system, with unique instructions that the customer uses to program the "computer."

The main advantage here is the ability of the motion controller to run the entire machine. (Since extra processor power isn't needed, the host CPU is free to do other tasks such as data acquisition, quality management, or even create the next motion program for the controller to execute.) Designing products with onboard processors and an OS allows them to reside either inside the PC, like a fax/modem card, or outside the PC like a printer. The primary difference is the communication path. Internal products communicate across the PC bus. External products are typically controlled serially, via one of the PC's serial ports.

The second type of motion controller architecture employs minimal hardware on the plug-in card, but uses the host PC's microprocessor to calculate motion trajectories and monitor all other aspects of motion. Some of these products have no processor onboard, while others include a processor to perform functions not feasible for the host CPU.

For instance, an onboard digital signal processor (DSP) may exclusively close the servo loop while the host calculates all motion set-points for the DSP. Examples of companies using the host PC design are Technology 80 Inc. (Minneapolis, Minn.) and Motion Engineering Inc. (MEI, Santa Barbara, Calif.).

This design approach offers advantages as well. The motion controller requires less hardware-usually a lower cost solution. Because the host processor performs all (or most) of the functions, synchronization between the motion and other machine-related functions is maintained. A disadvantage is that the approach can't offer the parallel-processing capabilities of the intelligent peripheral designs. Programmers typically use a library of built-in motion functions to get the motion controller to perform its tasks.

According to Geoffrey Grow, applications engineer at MEI, "This approach is sometimes called an application programming interface (API) - a portable tool kit of motion commands. MEI's Motion Control API is a set of high-level functions that communicates between our DSP-Series motion controllers and the machine's host computer. APIs can be designed to be independent of the operating system and the underlying hardware used by the machine manufacturer. As a result, a machine designer can choose virtually any compiler and operating system."

Customers can look forward to increased motion control capabilities when using either of the two major hardware approaches. Performance growth will come from a continuum of advances: improvements in controllers, more powerful processors added to intelligent peripherals to handle new operating system software features, and motion API libraries with exciting new features.

PC software will promote motion control advances

Supporting software

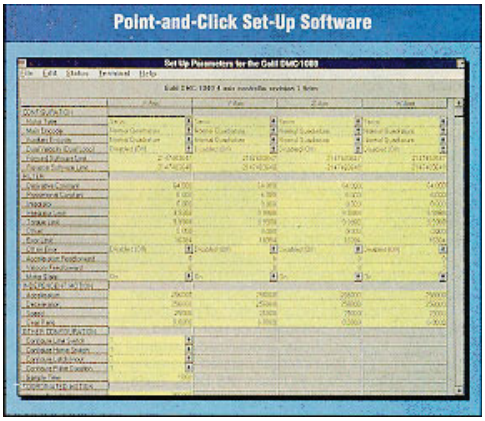
Some of the most significant advances in the motion control industry will be in PC software, according to the companies surveyed. They also tend to agree that software will make motion control hardware far easier to use in the future.

Emerson EMC continues to see movement towards easier-to-use front-end software. Marketing manager Bryan McGovern says, "The users of our motion control products are machine builders, factory personnel, and systems integrators. Most of them are not full-time programmers. Yet, their applications require complex positioning. By thoroughly understanding their application, we are able to offer an interface software program that merely requires the user to plug in parameters unique to the application, such as length of move, synchronization ratio, acceleration rate, and dwell time." Emerson offers a program called PCX to assist its customers in configuring applications.

Several companies now offer PC software that helps users set up their controllers and climb the motion control IC learning curve much faster.

For instance, Compumotor set an industry precedent with the 1992 introduction of Motion Architect, a Windows based product for generating all of the set-up code needed by a motion controller, and which is specifically configured for the users application. Customers just provide application-specific input by filling in a series of dialog boxes. Motion Architect also lets users create and edit motion programs, communicate with the controller, and create a custom test panel to display desirable information or verify proper machine sequencing.

Electro-Craft IQ Master for Windows from Reliance Motion Control (Eden Prairie, Minn.) is another example of an application development environment specifically designed to work with the controller manufacturers hardware.



Spreadsheet convenience is one f the features of the new Set-Up software from Galil Motion Control that lets motion system parameters be easily displayed or modified in this familiar format.

Dr. Jacob Tal, president of Galil Motion Control Inc. (Sunnyvale, Calif.) says, "One of the most significant results of the progress in the industry is that motion control systems are designed by non-specialists." Curtis Wilson, VP of engineering at Delta Tau Data Systems (Northridge, Calif.) agrees, saying, "Users are coming to expect as a given, the ability to have the computer provide expertise where the user does not. Galil recently released a Windows-based, point-and-click set-up software package, allowing users to configure their products easier than in the past. They can view the configuration status of the controllers in a spreadsheet format and click on a cell to enter a new parameter setting. Dr. Tal adds, "We design products that do not require expertise in motion control or computer programming."

Another area where software can lend expertise to motion control users is in the tuning of servo system loops. Most servo controller companies offer a servo-tuning aid program. Delta Tau and Compumotor, among others, have software for Windows to show how a system is performing. Compumotor's program, Servo Tuner, allows users to select and capture data they want to see. Data available for capture and display include the actual and commanded values for position, velocity, and acceleration, and the output command signal. For every servo update period, the requested- data are stored and graphically displayed on the computer to assist with tuning and system analysis.

Breaking the language barrier

Customers are still faced with translating the motion profiles of their application into the controllers unique programming language. This is traditionally where they must break out the motion controllers User Guide. As a result, motion control companies are developing tools to rapidly program their products. PC software is available to guide customers through programming functions ranging from feed-to-length to more complex synchronization of multiple axes.

An example of a two-axis software product that generates commands for coordinated motion without the need to learn the programming language is Compumotor's CompuCAM. This software converts a DXF drawing from AutoCAD, an HP-GL plotter file, or a CNC G-code program into the proper motion commands for Compumotor's 6000 Series controllers to perform, the described motion. Galil offers a similar software package to translate DXF, HP-GL, or G-code files into motion instructions appropriate for its DMC Series controllers.

More of these PC software products will be available as motion control companies race to capture market share by making their hardware easier to apply. Customers will be drawn to programs requiring the least amount of work to reliably solve problems.

Use of the PC as the motion controller platform is another major development. Pacific Scientific, Motion Technology Div. (MTD, Boston, Mass.), recently introduced Advanced Motion Language (AML), a Windows-based development and debugging environment, designed to create multiaxis motion programs for fieldbus-based drives. AML's novelty is that it's essentially a "soft" motion controller, with the program it generates targeted to run on a PC platform. The only hardware required for the controller to work is the fieldbus communication port. AML supports the SERCOS fiber-optic communication protocol between controls and drives, and is being enhanced to handle a variety of I/O bus networks. (For more about AML, refer to *CE,* July 1995, P. 119.) W. Hal Gurley, Pac Sci MTD director of marketing, says AML reflects his company's vision of things to come. "In the future, multiaxis motion controllers may be almost 100% soft versus hard, because it will be the only way to capitalize on the rapid advances in PC-compatible technologies. Suppliers in the motion control industry that have invested in 'black box' hardware solutions will ultimately die if they do not embrace more of a soft solution."

Visual programming is a new frontier in motion control

Icons - a new frontier

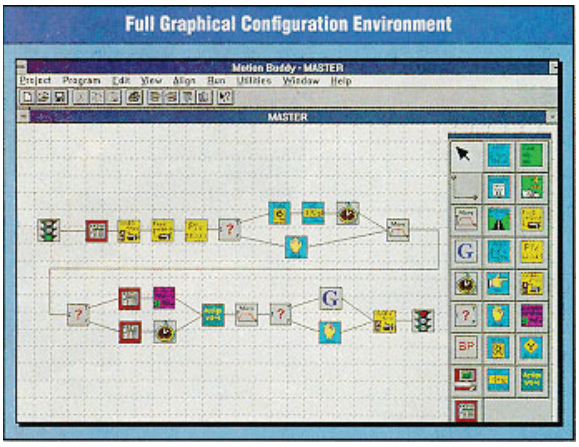
Visual programming - of the newest frontiers in motion control - lets customers program controllers without having to learn a

written language or syntax. Users first drop visual icons onto the screen that correspond to specific functions they want to implement. Clicking on the icons with a mouse opens dialog boxes that allow the icons to be configured to a specific application. Next, the icons are connected to indicate the program flow. Once all functions are in place, configured, and linked, the application can be compiled and executed.

Allen-Bradley's Motion Control Group (Mequon, Wis.) was the first to offer this type of visual programming in a package called GML (Graphical Motion Language). After a GML diagram is developed and downloaded to a controller, the application can be completely debugged using the graphical trace feature. It allows the programmer to graphically view program execution as it was entered. GML's on-line manager further simplifies axis configuration and tuning.

Once entered, tuning parameters are executed by a mouse click. All axis gain values and dynamics are calculated and saved in the GML diagram.

"We have found that GML significantly reduces program development time by allowing the programmer to focus on application details without having to first learn the syntax of a specific programming language," explains Bob Hirshinger, product manager for A-B's Motion Drives Systems. Future enhancements of GML include support for OLE and Windows 95, as well as on-line help and documentation.



Motion Builder is Compumotor's latest software product. It uses a graphical environment to configure, program, compile, run, and debug a motion system, all with the same tool.

Compumotor's latest software offering, Motion Builder, is also a graphical environment. It can completely configure the motion controller; program the motion with visual icons; and compile, run, and debug the program, all from the same tool. Users need only to select the specific Compumotor 6000 Series stepper or servo controller being applied.

Motion Builder is configured by answering a series of questions contained within drop-down dialog boxes. Programming is done by selecting motion functions from a floating palette and dropping them ' one by one, onto the chart. Each function's action is set up by a dialog box associated with an icon. When all functions are on the screen, a special palette tool connects the icons in a manner indicating the program flow. At this point the program is compiled and can be executed. Three debug modes are included in Motion Builder.

Dan Snider, president of Snider Consultants Inc. (Cary, N.C.)-a leading developer of systems integration software-likes the visual approach. Mr. Snider comments, "One trend in motion software is the use of visual development at the controller level. Unlike application software, visual development tools at this level are used to write 'controller targeted' programs. One approach is to provide a graphical front end that ultimately generates conventional controller code. Though useful for initial development, the benefits are diminished when faced with unfamiliar generated code at the debug phase.

To be effective, vendors need to supply a visual environment that allows the user to remain in the 'graphical domain' for all steps of the development process and insulates them from any low-level code required by the controller."

Application software

The next tier in PC motion software is intended to create programs to control the entire machine. Motion control is only one part of these higher-level applications. All that's left to do is configure software for a machine's specific requirements.

Some application-specific software is available from motion control companies, but the motive to create this product is usually to sell more hardware. Third-party vendors are another source, though not numerous, mainly due to incompatibility of a given company's motion language with another's motion hardware. A driver must be written to support each vendor's products if they're to be usable with the software package.

To maximize operator familiarity, Delta Tau's PMAC NC for Windows locates buttons that activate controller functions just like those on a CNC machine.

One example of an application-specific software is a product from Delta Tau called PMAC-NC for Windows. According to Curtis Wilson, "PMAC-NC for Windows turns a PC with a Delta Tau PMAC control card into a full-fledged

CNC controller. In contrast to proprietary software and hardware architectures that dominate the CNC world, this offers the builder many ways to achieve greater functionality and increases product differentiation."

The future promises to bring more software from motion control manufacturers to solve different application-specific machine control problems. But, until the correct software program is developed for a specific machine, customers will still have to write software that unifies all of their machine-related components.

Several companies currently offer visual development software at the application level, including LabVIEW from National Instruments (Austin, Tex.). Based on the number of users, LabVIEW is the most popular visual development software on the market, states Mr. Snider. "Using LabVIEW with a motion software add-on such as Compumotor's Motion Toolbox, users can develop entire applications that integrate motion with data acquisition, process control, database access, etc. This approach provides the developer with an environment that integrates all aspects of a system while leveraging the benefits of visual programming."

"Open Architectures" may expand motion software developments

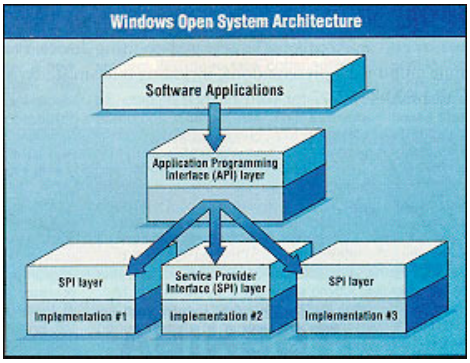
Windows of opportunity

On the Windows side of developments, many new products are emerging. For some time, motion companies have provided Dynamic Link Libraries (DLLs) to Windows developers. With the growth Of Microsoft's Visual Basic and Visual C++, motion companies are now developing or selling Visual Basic extension (VBX) tool kits to help integrate motion hardware into applications. VBX tools allow programmers to purchase built-in functionality, saving the time they would otherwise have to spend writing code, Both Compumotor and Galil offer VBX tool kits for their latest lines of motion controllers.

One of the latest trends for Windows application developers is the Object Linking and Embedding (OLE) Control extension (OCX) tool kit. OCX is the next generation of the VBX tool kit. VBXs are designed for today's 16-bit applications, while the OCXs take advantage of the OLE technology and are targeted for 32-bit development environments, such as Visual Basic 4.0 and the 32-bit edition of Visual C++.

While these tools ease the software integration task, it is still necessary that the developers use the proper VBX, OCX, or DLL for the specific motion control hardware. All of that may change with a new Windows development tool from ROY-G-BIV Corporation (Seattle, Wash.).

In a recent conversation, ROY-G-BIV's President and CEO, Dave Brown, explained the need for open software systems. "We see a trend toward building open systems designed to work with a variety of related, but incompatible, technologies. We have noticed extensive efforts in this area, while working on development tools with Microsoft and other companies. Microsoft has even coined a term 'Windows Open System Architecture' or WOSA. WOSA compliant technologies are open systems, where developers program to one layer of functions, called the Application Programming Interface (API), without being concerned about the implementation details of another layer, called the Service Provider Interface (SPI). The SPI is used by the API layer, but developed by the service provider who implements the technology."



In XMC, an open system for motion control from ROY-G-BIV Corp., developers program to the API layer, isolated from implementation details of the SPI driver that controls the underlying hardware.

Mr. Brown continued, "At ROY-G-BIV, we found WOSA to be an excellent framework that brings together all proprietary motion control command languages under one API. We have designed and developed a WOSA-compliant, OLE-based technology called XMC. Patent pending XMC is an open system for motion control, designed for software application developers."

Each motion control manufacturer that wants its hardware to be compatible with the XMCAPI must develop the XMCSPI supporting driver. These drivers can then be loaded into the completed application and selected as easily as choosing a printer driver in Windows. "XMC minimizes, and may even eliminate, any changes in motion control applications that wish to use different hardware systems," added Mr. Brown.

Another feature of XMC, the OLE Automation Interface, lets developers use high-level languages like Microsoft Visual Basic, with the benefit that applications created will work with motion hardware from any supplier that has an XMCSPI driver. This opens an opportunity for any software company to design an application without worry about market size limits

DOCKET ALARM

Explore Litigation Insights

Docket Alarm provides insights to develop a more informed litigation strategy and the peace of mind of knowing you're on top of things.

Real-Time Litigation Alerts

Keep your litigation team up-to-date with **real-time alerts** and advanced team management tools built for the enterprise, all while greatly reducing PACER spend.

Our comprehensive service means we can handle Federal, State, and Administrative courts across the country.

Advanced Docket Research

With over 230 million records, Docket Alarm's cloud-native docket research platform finds what other services can't. Coverage includes Federal, State, plus PTAB, TTAB, ITC and NLRB decisions, all in one place.

Identify arguments that have been successful in the past with full text, pinpoint searching. Link to case law cited within any court document via Fastcase.

Analytics At Your Fingertips

Learn what happened the last time a particular judge, opposing counsel or company faced cases similar to yours.

Advanced out-of-the-box PTAB and TTAB analytics are always at your fingertips.

API

Docket Alarm offers a powerful API (application programming interface) to developers that want to integrate case filings into their apps.

LAW FIRMS
Build custom dashboards for your attorneys and clients with live data direct from the court.

Automate many repetitive legal tasks like conflict checks, document management, and marketing.

FINANCIAL INSTITUTIONS
Litigation and bankruptcy checks for companies and debtors.

E-DISCOVERY AND LEGAL VENDORS
Sync your system to PACER to automate legal marketing.