Programmable Controller Software & Hardware

September 2018

Sponsored by Automation Direct
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Introduction and methodology

Objective
This study was conducted by Control Engineering to acquire information related to the buying and specifying habits of automation engineering professionals for programmable controller software and hardware.

Sample
The sample was selected from qualified subscribers of Control Engineering products with valid email addresses who are involved in the purchase or specification of control systems, including human-machine interfaces (HMIs), programmable logic controllers (PLCs), programmable automation controllers (PACs), distributed control systems (DCSs), and single-loop or PC-based controllers.

Method
Subscribers were sent an email asking them to participate in this study. The email included a URL linked to the questionnaire. Qualifying questions limited survey respondents to those who are involved in specifying, recommending, and/or buying programmable controller software and hardware.

- **Data collected:** July 17 through August 5, 2018
- **Number of respondents:** 363
  - Margin of error: +/- 5.1% at a 95% confidence level
- **Incentive:** Survey participants were offered the opportunity to enter a drawing for a $100 Visa gift card.
Summary of findings

The *Control Engineering* 2018 Programmable Controller Software & Hardware Study unveiled six key findings regarding what end users expect and how they purchase or specify industrial controller software and hardware:

1. **Usage of industrial controller software, hardware:** Programmable controller software or hardware is most commonly used for continuous manufacturing (24%), discrete and continuous manufacturing (23%), or continuous and batch manufacturing purposes (20%).

2. **Applications:** 63% of end users already use industrial controllers to help with remote monitoring tasks; another 54% use these products for maintenance, 41% for simulations, and 25% as a mobile interface for alarm functions.

3. **Justifications:** The top situations in which end users purchase new industrial controller software and/or hardware are an automation upgrade (68%), a new installation (53%), and an operations/engineering upgrade (40%).

4. **Cybersecurity:** 71% of respondents reported that their companies restrict access to controllers in an effort to protect these devices; 55% have increased password protection procedures.

5. **Spending:** Over the past 12 months, the average respondent’s company was estimated to have been spent $184,000 on industrial controller software and hardware—an increase of 17% over 2017 data.

6. **Looking ahead:** 82% of end users expect to buy industrial controller software or hardware in the next 12 months; end users expect to use/purchase an average of 21 industrial controllers during this time frame.
Respondent profile
Thirty-seven percent of survey respondents are primarily responsible for system or product design and/or control or instrument engineering at their companies; 22% are mainly involved in system integration or consulting.

**Primary job function**

- **System or product design, control or instrument engineering** 37%
- **System integration or consulting** 22%
- **Other engineering** 14%
- **Process, production, or manufacturing engineering** 10%
- **General or corporate management** 7%
- **Operations or maintenance** 7%
- **Other** 2%
- **Not available** 1%

**Q: What is your primary job function? (n=363)**
Twelve percent of respondents’ companies primarily manufacture instrumentation, control systems, test, measurement, or medical equipment. The top six (of 25) businesses comprise 47% of the total.

### Primary Business Chart

<table>
<thead>
<tr>
<th>Business</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instrumentation, control systems, test, measurement, medical</td>
<td>12%</td>
</tr>
<tr>
<td>System integration, consulting, business, or technical services</td>
<td>10%</td>
</tr>
<tr>
<td>Machinery</td>
<td>7%</td>
</tr>
<tr>
<td>Automotive, other transportation equipment</td>
<td>6%</td>
</tr>
<tr>
<td>Food, beverage, tobacco</td>
<td>6%</td>
</tr>
<tr>
<td>Utilities incl. electric, gas, water &amp; waste, telecommunications</td>
<td>6%</td>
</tr>
<tr>
<td>Oil, gas, petroleum, incl. refining</td>
<td>5%</td>
</tr>
<tr>
<td>Chemicals</td>
<td>4%</td>
</tr>
<tr>
<td>Miscellaneous or other manufacturing</td>
<td>4%</td>
</tr>
<tr>
<td>Computers, communications, consumer electronics, etc.</td>
<td>4%</td>
</tr>
<tr>
<td>Government or military</td>
<td>4%</td>
</tr>
<tr>
<td>Fabricated metals</td>
<td>3%</td>
</tr>
<tr>
<td>Electrical equipment, appliances, components</td>
<td>2%</td>
</tr>
<tr>
<td>Plastics, rubber</td>
<td>2%</td>
</tr>
<tr>
<td>Wood, paper, related printing activities</td>
<td>2%</td>
</tr>
<tr>
<td>Pharmaceuticals</td>
<td>2%</td>
</tr>
<tr>
<td>Aircraft, aerospace, defense</td>
<td>2%</td>
</tr>
<tr>
<td>Plant/facilities engineering or maintenance services</td>
<td>2%</td>
</tr>
<tr>
<td>Mining, mineral products</td>
<td>1%</td>
</tr>
<tr>
<td>Primary metals</td>
<td>1%</td>
</tr>
<tr>
<td>Information, data processing, or software, services</td>
<td>1%</td>
</tr>
<tr>
<td>Textiles, apparel, leather products</td>
<td>1%</td>
</tr>
<tr>
<td>Distribution centers, warehousing</td>
<td>&lt;1%</td>
</tr>
<tr>
<td>Hospitals, health care facilities</td>
<td>&lt;1%</td>
</tr>
<tr>
<td>Other</td>
<td>3%</td>
</tr>
<tr>
<td>Not available</td>
<td>11%</td>
</tr>
</tbody>
</table>

*Q: What is the primary business at your location? (n=363)*
Sixty-four percent of respondents' facilities employ fewer than 250 people; the average facility has 344 employees; 25% are in facilities of 500 or more.

Q: How many people work at your location? (n=328)
Location within U.S.

Twenty-five percent of respondents are based along the East Coast of the United States; the four central regions account for 40%; Mountain and Pacific areas are just 13%.

*Data gathered using Control Engineering subscriber information; respondents were matched to their subscription profiles.*
Uses for programmable controller software or hardware

The top uses for programmable controller software or hardware are discrete and continuous manufacturing (23% primary, 20% secondary) and continuous manufacturing (24% primary, 17% secondary).

Q: What are your primary and secondary uses for programmable controller software or hardware? (n=363)
Programmable controller software and hardware
The majority of respondents need or would be interested in PLC programming functions for controller software; other top functions include HMI development, remote monitoring, and SCADA. Fifty-three percent were interested in data analytics from the process.

Q: What functions do you need (or would you be interested in) for controller software? Check all that apply. (n=363)
Controller features, functionalities

The top features/functions respondents' controllers have are proportional-integral-derivative (PID) control, communications with devices or systems outside of the control loop, simulation, advanced control, and automated tagging of HMI and other assets.

Q: What features and/or functionality do your controllers have (or need)? Check all that apply. (n=363)

PID control: 77%
Communications with devices or systems outside of the control loop: 61%
Simulation: 48%
Advanced control: 47%
Automated tagging of HMI and other asset tags: 47%
Testing: 42%
Code libraries: 41%
Embedded safety: 41%
Embedded motion: 34%
Simplified licensing: 34%
Energy monitoring: 32%
Industry-specific capabilities: 32%
Adaptive control: 31%
Robotics integration: 31%
Embedded cybersecurity: 26%
Code translation from other platforms: 24%
Virtualization: 21%
Server virtualization: 19%
Drill-down capability to asset information: 18%
Cloud connections: 17%
Middleware links or connectivity software: 16%
Artificial intelligence integration: 15%
Asset optimization: 15%
Multi-core support: 11%
Other: 1%

Q: What features and/or functionality do your controllers have (or need)? Check all that apply. (n=363)
Thirty-seven percent of respondents reported that most of their controllers network with PLCs, compared to 21% that network with a DCS, 12% with PACs, and 11% with industrial PCs. About one-fifth (18%) stand alone.

Q: How do most of your controllers interface with other control systems? (n=363)
Communication protocols

More than half of respondents’ controllers are using 4-20 mA/0-10 V dc, Ethernet, RS-232/RS-485, and/or Modbus TCP communications protocols.

<table>
<thead>
<tr>
<th>Protocol</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-20 mA/0-10 V dc</td>
<td>76%</td>
</tr>
<tr>
<td>Ethernet</td>
<td>73%</td>
</tr>
<tr>
<td>RS-232/RS-485</td>
<td>61%</td>
</tr>
<tr>
<td>Modbus TCP</td>
<td>55%</td>
</tr>
<tr>
<td>EtherNet/IP (ODVA)</td>
<td>47%</td>
</tr>
<tr>
<td>Profibus-DP, -FMS, -PA</td>
<td>36%</td>
</tr>
<tr>
<td>Profinet</td>
<td>31%</td>
</tr>
<tr>
<td>A-B Remote I/O</td>
<td>28%</td>
</tr>
<tr>
<td>DeviceNet (ODVA)</td>
<td>28%</td>
</tr>
<tr>
<td>HART</td>
<td>26%</td>
</tr>
<tr>
<td>ControlNet</td>
<td>24%</td>
</tr>
<tr>
<td>High-speed Ethernet</td>
<td>17%</td>
</tr>
<tr>
<td>Wireless/Bluetooth</td>
<td>17%</td>
</tr>
<tr>
<td>IO-Link</td>
<td>16%</td>
</tr>
<tr>
<td>EtherCAT</td>
<td>13%</td>
</tr>
<tr>
<td>CANopen</td>
<td>12%</td>
</tr>
<tr>
<td>SERCOS</td>
<td>12%</td>
</tr>
<tr>
<td>AS-Interface</td>
<td>10%</td>
</tr>
<tr>
<td>Binary coded decimal</td>
<td>10%</td>
</tr>
<tr>
<td>Foundation Fieldbus</td>
<td>10%</td>
</tr>
<tr>
<td>UDP</td>
<td>9%</td>
</tr>
<tr>
<td>CC-Link</td>
<td>4%</td>
</tr>
<tr>
<td>Ethernet Powerlink</td>
<td>4%</td>
</tr>
<tr>
<td>LonWorks</td>
<td>3%</td>
</tr>
<tr>
<td>ARCNet</td>
<td>2%</td>
</tr>
<tr>
<td>Interbus</td>
<td>2%</td>
</tr>
<tr>
<td>IEEE TSN</td>
<td>2%</td>
</tr>
<tr>
<td>Seriplex</td>
<td>1%</td>
</tr>
<tr>
<td>WorldFIP</td>
<td>0%</td>
</tr>
<tr>
<td>Other communications</td>
<td>5%</td>
</tr>
</tbody>
</table>

Q: Which of the following communications protocols are your controllers using? Check all that apply. (n=363)
Communications software/methods

Forty-five percent of respondents’ controllers use the OPC UA communications software, while 25% use another OPC Foundation communication, and 21% use another custom software communication altogether.

<table>
<thead>
<tr>
<th>Software/Method</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>OPC Unified Architecture (UA)</td>
<td>45%</td>
</tr>
<tr>
<td>Other OPC Foundation communications</td>
<td>25%</td>
</tr>
<tr>
<td>Data Distribution Service (DDS) from OMG</td>
<td>8%</td>
</tr>
<tr>
<td>Common Conceptual Object Model (CCOM) from MIMOSA</td>
<td>6%</td>
</tr>
<tr>
<td>Message queueing telemetry transport (MQTT), an OASIS standard</td>
<td>6%</td>
</tr>
<tr>
<td>Other software-based standard</td>
<td>7%</td>
</tr>
<tr>
<td>Other custom software communications</td>
<td>21%</td>
</tr>
<tr>
<td>None of the above</td>
<td>10%</td>
</tr>
<tr>
<td>Don’t know</td>
<td>18%</td>
</tr>
</tbody>
</table>

Q: What communications software/methods do your controllers use? Check all that apply. (n=363)
The majority (84%) of respondents use or expect to use ladder diagrams over the next 12 months, while 63% use/expect to use function block diagrams (up from 54% in 2017).

Q: Which of the following programming languages/methods do you use/expect to use in coming year? Check all that apply. (n=363)

- Ladder diagram: 84%
- Function block diagram: 63%
- Sequential function chart: 38%
- Structured text: 38%
- Object-oriented programming: 34%
- C: 31%
- Proprietary programming software: 28%
- Instruction list (statement list): 25%
- Flowchart: 22%
- Basic: 18%
- In-context programming: 4%
- Other: 4%
Software integration functions

With regards to integration functions of controller software, two-thirds of respondents take advantage of capabilities between versions and 43% have observed the ease of integrating data from other systems.

Q: What integration function(s) do you use in your controller software? Check all that apply. (n=363)

- Capability with prior versions: 66%
- Ease of integrating data from other systems: 43%
- Historian integration: 40%
- Recipe management integration: 31%
- Integration: MES integration: 16%
- IIoT-cloud integration: 15%
- ERP integration: 10%
- Other integration: 2%
The top programming, topology, or setup functions used in controller software include ladder logic (78%); function blocks (58%); full IEC 61131-3 language support (48%); and function/code libraries, object-oriented code (42%).

<table>
<thead>
<tr>
<th>Function</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ladder logic</td>
<td>78%</td>
</tr>
<tr>
<td>Function blocks</td>
<td>58%</td>
</tr>
<tr>
<td>Full IEC 61131-3 language support</td>
<td>48%</td>
</tr>
<tr>
<td>Function/code libraries, object-oriented code</td>
<td>42%</td>
</tr>
<tr>
<td>Client-server capability</td>
<td>33%</td>
</tr>
<tr>
<td>Structured text</td>
<td>33%</td>
</tr>
<tr>
<td>Automated tagging</td>
<td>31%</td>
</tr>
<tr>
<td>Sequential function charts</td>
<td>29%</td>
</tr>
<tr>
<td>Simulation capabilities</td>
<td>25%</td>
</tr>
<tr>
<td>Custom programming tools</td>
<td>23%</td>
</tr>
<tr>
<td>Configuration instead of programming</td>
<td>21%</td>
</tr>
<tr>
<td>Instruction list</td>
<td>20%</td>
</tr>
<tr>
<td>Industry specific functions</td>
<td>16%</td>
</tr>
<tr>
<td>Multi-client, multi-server</td>
<td>12%</td>
</tr>
<tr>
<td>Cloud and distributed systems capability</td>
<td>8%</td>
</tr>
<tr>
<td>Other controller software functions</td>
<td>1%</td>
</tr>
</tbody>
</table>

Q: What programming, topology, or setup functions do you use in your controller software? Check all that apply. (n=363)
The top sales, services, and support offerings respondents take advantage of with their controller software are upgrades and patches, free upgrades, ease of licensing (flat fee for unlimited use), and online training.

- Upgrades, patches: 46%
- Upgrades, free: 42%
- Ease of licensing (flat fee for unlimited use): 38%
- Training: online: 38%
- Customization or modification: 36%
- Training: in-person: 36%
- Ease of licensing (automated): 34%
- Quantity pricing: 24%
- Try before you buy: 18%
- Other: 2%

Q: What sales, services, and support offerings do you use in your controller software? Check all that apply. (n=363)
Controller usage: integration

Sensor-to-controller and controller-to-controller integration are most common among survey respondents, followed by controller-to-plant-system.

Q: How are you using controllers related to the following? (n=363)

- Sensor to controller: 57% Integrated, 24% Somewhat integrated, 9% Considered; not integrated
- Controller to controller: 52% Integrated, 28% Somewhat integrated, 8% Considered; not integrated
- Controller to plant system: 38% Integrated, 30% Somewhat integrated, 15% Considered; not integrated
- Controller to edge device or data: 13% Integrated, 21% Somewhat integrated, 17% Considered; not integrated
- Controller to private or public: 13% Integrated, 20% Somewhat integrated, 17% Considered; not integrated

Q: How are you using controllers related to the following? (n=363)
Consideration for using new, lower-cost controller

When connecting to edge devices, 61% of respondents would consider using a new, lower-cost controller over a traditional controller; 11% are already doing so.

Q: When connecting to edge devices, would you consider using a new, lower-cost, controller (rather than a more traditional controller)? (n=363)
Sixty-three percent of industrial controllers help with remote monitoring, 54% contribute to maintenance tasks, and 41% assist with simulation. Industrial controllers are also being considered as mobile interfaces for alarming and programming functions.

Q: How are industrial controllers helping with the following? (n=363)
Seventy-one percent of respondents’ companies restrict access to controllers as a means of cybersecurity. Other strategies include increased password protection procedures and restricted physical access to controllers.

<table>
<thead>
<tr>
<th>Controller Cybersecurity Measures</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Restrict access to controllers</td>
<td>71%</td>
</tr>
<tr>
<td>Increased password protection procedures</td>
<td>55%</td>
</tr>
<tr>
<td>Restrict physical access to controllers</td>
<td>54%</td>
</tr>
<tr>
<td>Reviewed network access points for vulnerabilities</td>
<td>38%</td>
</tr>
<tr>
<td>Performed a cybersecurity assessment</td>
<td>25%</td>
</tr>
<tr>
<td>Required personnel with access to take cybersecurity training</td>
<td>22%</td>
</tr>
<tr>
<td>Offered personnel with access to take cybersecurity training</td>
<td>10%</td>
</tr>
<tr>
<td>Other</td>
<td>4%</td>
</tr>
<tr>
<td>Don’t know</td>
<td>10%</td>
</tr>
</tbody>
</table>

Q: Which controller cybersecurity measures are in place? Check all that apply. (n=363)
Hardware communications features

Ethernet, TCP/IP; one Ethernet port (10/100/1000 Base-T); and serial connections (RS-232/422/485) are the top communications features used in respondents’ controller hardware.

<table>
<thead>
<tr>
<th>Feature</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethernet, TCP/IP</td>
<td>82%</td>
</tr>
<tr>
<td>Ethernet port (10/100/1000 Base-T Ethernet port)</td>
<td>58%</td>
</tr>
<tr>
<td>Serial connections (RS-232/422/485)</td>
<td>57%</td>
</tr>
<tr>
<td>Integrated I/O</td>
<td>44%</td>
</tr>
<tr>
<td>SD memory card slot</td>
<td>39%</td>
</tr>
<tr>
<td>Multiple I/O ports</td>
<td>36%</td>
</tr>
<tr>
<td>2 Ethernet ports (10/100/1000 Base-T Ethernet ports)</td>
<td>31%</td>
</tr>
<tr>
<td>Multiple USB ports</td>
<td>27%</td>
</tr>
<tr>
<td>Gigabit LAN</td>
<td>25%</td>
</tr>
<tr>
<td>Wireless capability</td>
<td>25%</td>
</tr>
<tr>
<td>3+ Ethernet ports (10/100/1000 Base-T Ethernet ports)</td>
<td>24%</td>
</tr>
<tr>
<td>HDMI port</td>
<td>20%</td>
</tr>
<tr>
<td>VGA and DVI-I input ports</td>
<td>13%</td>
</tr>
<tr>
<td>DVD</td>
<td>4%</td>
</tr>
<tr>
<td>Other hardware communications (not software)</td>
<td>2%</td>
</tr>
</tbody>
</table>

Q: What communications features do you use in your controller hardware? Check all that apply. (n=363)
Purchasing/specifying programmable controller software and hardware
Forty-two percent of respondents generally buy or specify controller software separately from controller hardware. Controllers are typically purchased from a local distributor (70%) or directly from a vendor (38%).
Justifying new controller software or hardware

The top reasons for justifying the purchase or specification of new industrial controller software and/or hardware are an automation upgrade (68%), new installation (53%), or operations/engineering upgrade (40%).

Q: What justification do you use for new industrial controller software and/or hardware? Check up to three (3) options below. (n=363)

- Automation upgrade: 68%
- New installation: 53%
- Operations/engineering upgrade: 40%
- Safety program: 17%
- Industrial Internet of Things: 16%
- Enterprise upgrade: 14%
- Overall equipment effectiveness: 14%
- Training becomes easier: 9%
- Industrie 4.0: 6%
- Helps fulfill regulatory requirements: 5%
- Cybersecurity risk is less: 3%
- Other KPI or justification: 1%
- Other: 4%
Is purchase bound to existing standards?

For 63% of respondents, the purchase of industrial controller software or hardware is not bound to existing purchase agreements or company standards.

Q: Is purchase of industrial controller software or hardware bound to existing purchase agreement or company standards, or can you be open to new vendors? (n=363)
Controller software, hardware spend over past 12 months

In the past 12 months, respondents spent an average of $183,746 on industrial controller hardware and software (an increase of 17% over 2017 data)—with 26% having spent $200,000 or more.

Q: In U.S. dollars, what did you approximately spend on industrial controller hardware and software in the past 12 months? (n=363)
Eighty-two percent of respondents expect to buy industrial controller software or hardware in the next 12 months. On average, respondents plan to use 21 controllers over this period—up from the previously expected 9 controllers reported in 2017. Nearly one-fifth (19%) expect to use more than 25 controllers.

Q: Do you expect to buy industrial controller software or hardware in the next 12 months? (n=363); Q: How many industrial controllers do you plan to use over the next 12 months? (n=291)
Respondents expect to spend an average of $161,479 on industrial controller hardware and software over the next 12 months, with 23% expecting to spend $200,000 or more.

Q: In U.S. dollars, what would you expect to spend on industrial controller hardware and software in the next 12 months? (n=297)
Controllers, programming training

Respondents agree that training opportunities on or from controller hardware providers and controller software providers would be beneficial.

<table>
<thead>
<tr>
<th>Training Source</th>
<th>Very useful</th>
<th>Useful</th>
</tr>
</thead>
<tbody>
<tr>
<td>Controller hardware provider</td>
<td>55%</td>
<td>40%</td>
</tr>
<tr>
<td>Software provider</td>
<td>55%</td>
<td>40%</td>
</tr>
<tr>
<td>System integrators</td>
<td>28%</td>
<td>48%</td>
</tr>
<tr>
<td>Engineering technology publishers</td>
<td>16%</td>
<td>52%</td>
</tr>
<tr>
<td>Machine builders</td>
<td>22%</td>
<td>42%</td>
</tr>
<tr>
<td>Colleges, universities, community colleges, trade schools</td>
<td>17%</td>
<td>43%</td>
</tr>
<tr>
<td>Consultants</td>
<td>16%</td>
<td>42%</td>
</tr>
</tbody>
</table>

Q: Optional: Regarding education about controllers and programming, what are your views about the following training? (n=332;332;326;321;322;322;320)
Additional resources

Thank you for downloading the 2018 Programmable Controllers Software & Hardware Report! Use the links below to access additional information on related news, products, and research.

Articles, news, case studies, products
- Control systems: PLCs, PACs
- Discrete manufacturing: PLCs, PACs
- Networking and security: cybersecurity
- New Products for Engineers

Editorial research studies
- 2018 Career & Salary Study
- 2018 HMI Hardware & Software Study
- 2018 ERP, IIoT & the Cloud Study
- More research: www.controleng.com/ce-research

Programs, resources
- Global System Integrator Database
- Engineers’ Choice Awards
- Online Training Center
- Videos
- Webcasts
- Case studies
- eGuides
- Newsletters

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