Survey Analysis: Automation Plans and Problems

Walter F. Kozikowski

What problems limit this reporting entity’s manufacturing automation efforts? (For each, indicate as very much a problem, somewhat a problem, or not much of a problem.)

- Lack of design and engineering staff knowledge (and time)
- Lack of central computer or MIS staff knowledge
- Lack of operator or foreman acceptance
- Lack of information on equipment and software capabilities
- Lack of inside or outside programming capabilities
- Lack of outside consultants to assist the effort
- Lack of higher management interest
- Lack of suppliers to take entire system responsibility
- Lack of organized-labor support
- Lack of signal quality of phone (and related) lines
- Lack of low-noise alternating current power lines
- Lack of machine-to-machine interface capabilities
- Lack of communications format
- Lack of mechanical reliability
- Lack of electrical/electronic reliability
- Lack of equipment

Exhibit 1. 1983 Survey Question Used to Identify Roadblocks to Automation

Improvements in product quality, productivity, and production control are just a few of the arguments for industrial automation that should persuade plant managers to automate today. But few trips to local manufacturing facilities are needed to make the visitor see that the adoption of automation technology in American industry is progressing slowly at best. What is impeding the adoption of automation technology? Do American manufacturers plan on automating? What direction will their automation efforts take? What problems will plant managers face as they begin these efforts?

The National Electrical Manufacturers Association (NEMA) conducted two surveys of executive-level automation users to help answer these questions. In this article, W.F. Kozikowski, staff executive in NEMA’s Automated Systems Group, summarizes the key results of these surveys and analyzes their implications for manufacturing managers who must overcome the problems associated with adopting automation technology.

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To identify the primary roadblocks to manufacturing automation, NEMA surveyed its 550 member companies in the fall of 1983.1 Responding to the survey were 159 manufacturers of such diverse product lines as industrial controls, medical equipment, and wire and cable. A second survey, conducted in the fall of 1984,2 focused on manufacturers’ five-year industrial automation plans. This survey was mailed to 1,066 manufacturing firms that subscribe to Tech Alert, NEMA’s bimonthly newsletter on factory automation. The 188 responding firms, like the first group of respondents, produce a wide range of products, including automobiles, food products, and electrical products. About 30 percent of the responding firms are NEMA members.

What are the Roadblocks to Automation?

The principal question on the 1983 survey was “What problems limit this reporting entity’s manufacturing automation efforts?” Exhibit 1 lists the items that survey respondents were asked to rate as very much a problem, somewhat a problem, or not much of a problem. Exhibit 2 shows the five items most frequently cited as problems and breaks down the ratings; four of these five items are related to insufficient knowledge within the reporting entity.

Lack of time and knowledge within the design and engineering staff restricts the automation efforts of 73 percent of the respondents (i.e., 73 percent labeled this very much a problem or somewhat a problem). Lack of time is a traditional problem, but lack of staff knowledge is generally associated with the rapid rate of change in modern technology. The question then becomes, in what areas is lack of staff knowledge a problem?

Further analysis of Exhibit 2 helps to answer that question. The exhibit shows that 56 percent of the respondents rated lack of inside or outside programming capabilities as
a roadblock to automation in their facilities. In addition, 48 percent of the respondents are hampered by lack of industrial automation knowledge on the part of central computer or MIS staff. Finally, lack of information on equipment and software capabilities is a problem for 55 percent of the respondents.

The message from this survey is clear. During the 1970s, plant managers had difficulty integrating computer and software technology into their sales and accounting departments because companies lacked experienced staff. During the 1980s, plant managers are facing a similar problem in their attempts to integrate computer and software technology into their manufacturing operations.

Manufacturers’ Automation Plans

The roadblocks to industrial automation created by lack of in-house computer and software knowledge will become increasingly critical as more plant managers attempt to automate their machinery and plant communications systems. Manufacturers’ five-year plans for automation were the focus of the second NEMA survey.

Survey respondents were given a list of 11 types of industrial automation equipment (see Exhibit 3) and asked to indicate those that were installed in their manufacturing facilities or were scheduled for installation within the next five years. NEMA analyzed responses to distinguish between firms that plan to install automation equipment similar to equipment they already operate and firms that will be installing specific types of automation equipment for the first time. This distinction was deemed significant because of the learning process associated with initial installations.

Computer-aided design (CAD) systems led the list of planned installations; 39 percent of the survey respondents plan initial or additional CAD installations. Thirty-eight percent of the respondents plan to retrofit existing manual machines with some type of programmable or computerized control; 35 percent plan to install individual machines controlled by computers or programmable controllers for use in modifying discrete parts.

Many of the respondents already have experience with retrofitting or installing machines controlled by computers or programmable controllers. Sixty-three percent of the planned retrofit projects and 48 percent of the individual machine installations will be additions to present installations. Prior experience with programmable controller- and computer-controlled machinery will help plant managers and staff successfully implement these projects. Furthermore, because these projects are based on machinery-related technology — an area of manufacturing staff expertise — personnel should feel relatively comfortable working with this type of automation equipment.

Projects that involve the installation of CAD systems may be more difficult. Eighty-seven percent of the planned CAD systems will be initial installations. Not only do plant personnel lack experience in implementing CAD systems, but their lack of computer and software knowledge may seriously inhibit the successful implementation of this computer-based automation technology.

Other frequently planned automation projects may also suffer from the lack of in-house computer and software knowledge. The five-year plans of 34 percent of the survey respondents include the instal-

<table>
<thead>
<tr>
<th>Capability</th>
<th>Very Much a Problem</th>
<th>Somewhat a Problem</th>
<th>Not Much of a Problem</th>
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</thead>
<tbody>
<tr>
<td>Lack of design and engineering staff knowledge (and time)</td>
<td>21</td>
<td>52</td>
<td>27</td>
</tr>
<tr>
<td>Lack of inside or outside programming capabilities</td>
<td>17</td>
<td>39</td>
<td>44</td>
</tr>
<tr>
<td>Lack of information on equipment and software capabilities</td>
<td>10</td>
<td>45</td>
<td>45</td>
</tr>
<tr>
<td>Lack of machine-to-machine interface capabilities</td>
<td>14</td>
<td>39</td>
<td>47</td>
</tr>
<tr>
<td>Lack of central computer or MIS staff knowledge</td>
<td>11</td>
<td>37</td>
<td>52</td>
</tr>
</tbody>
</table>

Exhibit 2: Top Five Problems Identified by 1983 Survey Respondents

Which of the following types of industrial automation equipment do you presently have installed or plan to install within the next five years?

- Computer-aided design
- Computer-aided engineering
- Retrofits of existing manual machines with computer numerical control, programmable controller, or other computerized controls
- Individual machines, controlled by dedicated computers or programmable controllers, that form, machine, weld, or otherwise physically modify discrete parts
- Individual machines, controlled by dedicated computers or programmable controllers, that assemble discrete parts
- Groups of independent machines, controlled by a single computer or programmable controller, that form, machine, weld, or otherwise physically modify discrete parts
- Groups of independent machines, controlled by a single computer or programmable controller, that assemble discrete parts
- Dedicated hard-automation centers, such as transfer lines or assembly machines
- Automatic storage and retrieval to supply factory floor machines
- Automated testing or inspection of parts or assemblies
- Automated parts tracking or recognition

Exhibit 3: 1984 Survey Question Used to Determine Manufacturers’ Plans for Automation
ation of computer-aided engineering (CAE) systems; 88 percent of the systems will be initial installations. Thirty-three percent of the respondents plan to install automated parts tracking and recognition systems; 91 percent of these companies will be doing so for the first time. Because both CAE and automated parts tracking and recognition technologies are computer and software based, staff members' lack of experience with the technology and unfamiliarity with computers and software will make the successful installation of these systems a significant challenge.

Other Plans for Automation

The configuration of equipment into flexible manufacturing units and the installation of local area networks (LANs) are included in many of the respondents' five-year plans. These projects will also be affected by employees' lack of knowledge about computers and software. Survey responses project a fourfold increase in the installation of flexible manufacturing units by 1990. Thirty-five percent of the respondents plan flexible manufacturing systems, which have four or more machines. Forty-five percent of the respondents are planning LAN installations, including single plantwide LANs, intradepartmental LANS, and interdepartmental LANs. The number of planned LANs is three times the number of existing LANs.

Although there are hardware components to flexible manufacturing units and LANs, the operation of these systems is primarily based upon computer and software technologies, and an understanding of these technologies is necessary for successful implementation.

Responsibility for Automation Projects

Because many of the planned automation projects will require extensive computer and software support and in-house knowledge is currently lacking, plant managers must decide whether to develop in-house staff capabilities or to obtain assistance from outside sources. The 1984 survey requested plant managers to indicate who would be responsible for specifying, implementing, and engineering automation projects in their companies.

More than 60 percent of the survey respondents indicated that they will depend primarily on internal resources to perform these tasks; another 14 percent plan to obtain some assistance from external consultants, although the responsibility for the projects will remain in house. Thus, for nearly three-quarters of the survey respondents, in-house knowledge is crucial. Approximately 10 percent of the respondents will look to systems houses for turnkey solutions, and another 10 percent will rely on equipment manufacturers.

Bridging the Gap Between Experts and Users

Given the lack of knowledge about computers and software in many manufacturing facilities, an extensive educational program will be required if the in-house staff responsible for installing computer- and software-based industrial automation systems is to succeed. In-house staff need to become knowledgeable about pertinent areas of industrial automation and must achieve at least a basic understanding of the computer and software technology that drives automated systems. In most instances, however, plant staff need not become experts in such technology; automation equipment is becoming simpler to operate as software programs incorporate option menus and interactive capabilities to help guide equipment operators. Still, plant personnel must have a sufficient background to properly evaluate how well a given system will work in an application. In addition, present computer and software technology limits menu-driven and interactive changes to relatively modest program modifications. If major program changes are needed, a high level of expertise in computer and software technology is required.

The most knowledgeable sources of information on these new technologies are computer and software vendors. Manufacturers should develop working relationships with these vendors to enable the exchange of information. Traditionally, however, there is a large gap between production staff and vendor personnel. The 1984 NEMA survey asked plant managers to rank various sources of information on industrial automation. As Exhibit 4 indicates, manufacturers of industrial equipment received the highest ranking; the trade press, trade shows, and seminars were also rated relatively high. But, those individuals that best understand the technology of computer- and software-based automation systems —

<table>
<thead>
<tr>
<th>OVERALL RANK</th>
<th>AVERAGE RANKING</th>
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<tbody>
<tr>
<td>Manufacturing equipment manufacturers</td>
<td>1</td>
</tr>
<tr>
<td>Trade press</td>
<td>2</td>
</tr>
<tr>
<td>Trade shows</td>
<td>3</td>
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<tr>
<td>Seminars</td>
<td>4</td>
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<tr>
<td>Professional associations</td>
<td>5</td>
</tr>
<tr>
<td>Trade associations</td>
<td>6</td>
</tr>
<tr>
<td>Independent consultants</td>
<td>7</td>
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<tr>
<td>Computer manufacturers</td>
<td>8</td>
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<tr>
<td>Software suppliers</td>
<td>9</td>
</tr>
</tbody>
</table>

*Respondents were asked to rank the sources from 1 to 9, with 1 meaning the most beneficial and 9 meaning the least beneficial.

Exhibit 4. Survey Respondents' Ranking of Information Sources
the computer manufacturers and software suppliers — are ranked the lowest.

These results indicate that the problems associated with improving in-house technological knowledge may not be easily solved. Some effort is needed to bridge the gap that separates the experts and users.

The First Step: Education

Several organizations are attempting to bridge the gap between plant personnel and the computer and software experts. Although many projects are still in the developmental stage, several existing programs are designed to present information on computer and software technologies in a practical format for plant personnel. Public agencies, trade associations, professional societies, and commercial groups have established educational programs aimed at the practical application of these technologies. Some of these programs are designed to teach the plant manager what can be realistically expected from automation systems; others provide plant personnel with hands-on information related to automation projects. A list of some organizations sponsoring existing or planned programs is presented in the accompanying inset. In addition to the organizations listed, many other trade associations, professional societies, equipment manufacturers, and consultants provide applications-oriented educational programs. To better meet the needs of the many disciplines within the field of industrial automation, many of these educational programs have multiple sponsors. Programs jointly sponsored by traditional manufacturing organizations, such as manufacturing equipment vendors, and computer and software organizations help to integrate practical plant floor experience with the new automation technologies.

Planning for the Future

By developing a staff that is knowledgeable in industrial automation technology, including the computer and software area, the plant manager can increase the likelihood that industrial automation projects will be properly planned and implemented. Additionally, by developing contacts with the manufacturers of computer and software products, plant staff can keep abreast of emerging technologies and help direct the development of new products to meet their needs.

Plant managers should lay the groundwork now for future automation projects. To do this, they must evaluate the educational needs of staff and management, then aggressively pursue the appropriate educational opportunities. In so doing, they can overcome many of the roadblocks to automation.

A Sampling of Educational Resources

The Automation Forum
(202) 457-1975; William C. Rolland, executive director
Disseminates industrial automation information through publication of automation success stories, a national speakers' bureau, and workshops and seminars aimed at updating plant managers on the capabilities of industrial automation technologies. Founded in 1984, the Automation Forum is an alliance of manufacturers, users, and consultants.

The Control Data Corporation Institute for Advanced Technology
(800) 638-6590
The institute's Manufacturing Technology Series provides a variety of seminars, including on-site programs that focus on the application of computer-aided design/computer-aided manufacturing in manufacturing environments. A schedule of seminars is available.

The Instrument Society of America
(919) 549-8411
Sponsors local technical seminars and conferences on instrumentation in an automated environment, with primary emphasis on the process control industry. A major conference and exhibition are conducted each fall.

The International Flexible Automation Center
(317) 633-4210
Is developing a series of seminars and workshops that will offer hands-on experience with automation equipment. The organization's goal is to establish a permanent center where vendors can train users in the operation of automation equipment. An executive-level program is in the pilot stage.

The Manufacturing Automation Protocol Users Group
(313) 271-1500; Mark Shaw, administrator
Is developing an educational program on LANs to help support the factory LAN specification developed by General Motors Corporation, which the users' group endorses; programs will range from two-hour sessions for executives to two-week sessions for technicians.

The Manufacturing Productivity Center of the IIT Research Institute
(312) 567-4808
Sponsors programs aimed at increasing the productivity of American industry through new technology. A recent conference focused on new developments in artificial intelligence. A monthly publication features reprints from industrial automation trade journals highlighting methods of increasing productivity.

The Automated Manufacturing Research Center of the National Bureau of Standards
(301) 921-3421
Conducts a tour and seminar program twice a year. The center's facilities include an operating automated machining, inspection, and CAD system. Firms can also enroll employees in the Research Association Program, which involves working at the bureau on a project. Additional programs are scheduled throughout the year.

NEMA
(202) 457-1983; Walter Kozikowski, staff executive
Provides a free industrial automation video loan library, conducts and publishes automation surveys, and publishes a bi-monthly automation newsletter.

Robotic Industries Association
(313) 271-7800
Sponsors seminars and workshops focusing on the technologies associated with robotics. A calendar of events is available.

Society of Manufacturing Engineers
(313) 271-1500
Presents an extensive technical program of national and local workshops and seminars focusing primarily on discrete parts manufacturing. An extensive selection of educational video tapes is available for sale or rent.