Security and Technology: The Past 30 Years

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The past 30 years have brought significant changes in the application of security electronics and communications technologies to support the operational and security functions of correctional facilities. During the early 1970s, technology within a standard correctional facility was primarily limited to relatively simple systems to support door control and monitoring functions, and limited closed-circuit television functions, intercom systems and public address systems. The systems were generally structured as "stand-alone" systems. For example, door control systems were typically relay controlled or directly hard-wired, and the system typically would have been a product manufactured by one of the door lock manufacturers. In general, intercom and paging systems were furnished and installed by a subcontractor specializing in audio systems, while closed-circuit television systems were furnished and installed by another subcontractor specializing in those systems.

Today, the structure of security electronics and communications systems has changed significantly. Products are available that reflect significant technological advancements over those products available 30 years ago, and new products are constantly being introduced that must be considered for current and future applications.

The following will address selected technologies or products and the significance of the changes in the products or the development of new products or technologies that have impacted the structure and operations of security systems today as compared with systems incorporated into the correctional facility security system designs of the 1970s. Space limitations for this article preclude an extensive survey of this subject, and the absence of a specific product or technology from this material does not imply a lack of significance of the product or technology. In addition, the sequence of presentation for each of the following subjects does not weigh on the significance of the product or technology since all system components support the security and operational objectives of a correctional facility.

Controllers (Monitoring and Control)

In the early 1970s, controllers[1] for correctional facility operations were generally custom designed and employed by electromechanical relays used to perform logical functions. These controllers were generally hard-wired and provided little or no flexibility for changes and they were not networked.

By the mid to late 1970s, solid state controllers were introduced, which generally provided a means to program or modify monitoring and control functions by programming software associated with a microprocessor. Typically, changes in the logical functions would require burning the software into an EPROM (erasable programmable read-only memory) chip.

Controllers that were prevalent during the mid-1970s to mid-1980s were generally a custom product of a company that developed a product for primary use within a correctional facility or the product may have been a customized application of a product designed for other applications. For example, several of the manufacturers of control systems for the heating and air conditioning applications provided controllers for correctional facility applications. Essentially, all customized controllers incorporated proprietary software and features that impacted the procurement and maintenance process. The customized controllers incorporated programmable features and provided a means to network multiple controllers. In turn, the networking provided a means to practically and economically monitor and control devices from a remote point, which facilitated a more flexible monitoring and control structure for security staff.

By the mid-1980s, programmable logic controllers that were primarily designed and manufactured to support automated controls within the automobile manufacturing, petroleum and general industries, became economical and exhibited features and characteristics that would support the security functions of a correctional facility. A significant feature of the controllers was that the logical functions required were programmed via the use of ladder logic, which was a common programming form for relay logic control systems. This form of programming was not proprietary and expanded the programmer base to support the initial system programming at a new facility as well as providing the ability for future maintenance and/or programming modifications to be performed by someone other than the manufacturer of the controller device.

Today, the programmable logic controller is the dominant control device used to support the security electronics backbone of a correctional facility. It is a microprocessor-based system with the communications capability to network multiple controllers as well as to interface to local area networks (LAN) and directly to other equipments employing standardized data interfaces. Processor speeds and communications data rates have significantly increased such that delay times to execute a command are insignificant. It is anticipated that the programmable logic controllers will continue to serve as a basic element of network controllers integrated within the security electronics and communications system structure of correctional facilities.

Operator Interfaces

A typical security control room in the early 1970s included relatively large, individual control panels for door control and monitoring functions, and for intercom and paging functions. Closed-circuit television monitors were often mounted on walls or located in adjacent sections of the control console. The operation of each of the individual systems was independent of the other systems and required multiple actions by security staff to control a door, select an intercom station and select the appropriate closed-circuit television camera for viewing the remote event.

Door control panels were generally large panels incorporating line voltage (120 volt), industrial-type switches. Intercom systems were typically an extension of the switch arrays that were commonly used in schools.

To activate the required control functions, each cable or conductor associated with the panel was typically routed directly to the control panel location. This resulted in a large quantity of cables and associated termination equipment being located below or adjacent to control panels. These wiring or cabling constraints imposed significant negative factors as related to the maintenance of the systems and severely restricted the relocation of or modification to the panels.

With the advent of the microprocessor controllers, as addressed earlier, the cabling system structure was modified to route all device cabling to a security electronics equipment room in which the microprocessor controllers were located. This facilitated a system structure that employed low-voltage cable systems to be routed from the equipment room to the control panels and eliminated many of the cable congestion problems previously experienced.

As microprocessors continued to develop, hardware became available to install a microprocessor on the control panel and only a data link was required to effect control functions from the control panel to the microprocessor controller located in the equipment room. This system architecture provided significantly more flexibility with regards to maintenance of and modifications to the control and monitoring functions, and simplified cabling systems.

By the early to mid-1980s, control panels were typically configured with laminated membrane switches or small electromechanical switches that replaced the large industrial switches and lamps previously incorporated within control panels. These changes facilitated the increase in the density of control and monitoring functions incorporated within a control panel and was, therefore, a more efficient operator panel. The microprocessor controllers provided operator efficiencies since a single operator function would initiate a sequence of control or monitoring functions, which previously had required multiple operator functions. For example, acknowledging an intercom call request now would automatically select the proper audio talk path, select the appropriate closed-circuit television camera and route the video image to the appropriate video monitor.

Significant changes in the options for an operator interface occurred in the early to mid-1990s. Personal computers had developed with significant memory capacity and speed to support the functions required for a video operator interface terminal. Customized software was developed and was

available from several sources to configure the computer screen as a control panel. Interaction with the control screen could be by the use of a touch screen, by the common mouse or by other conventional control devices. This technology facilitated the routing of control and monitoring information to the operator interface on a demand or as-needed basis and eliminated the requirement for large panels to be located at each operator position.

Human machine interface software continues to develop. Operating speeds and memory capacity of personal computers have increased dramatically, and video display terminals have made significant enhancements in recent years and will continue to do so. These developments have resulted in an increased use of computers and video terminals as viable options for security staff operator terminals. With the development of flat panel technology, casework requirements have changed such that the depths of casework are significantly reduced over panel configurations of the past. Ergonomics are more easily supported by the configurations of the equipment presently available for use at each operator position.

Networks

Networks that provide a communication linkage between distributed system components were essentially nonexistent within the correctional facility security system in the early 1970s. As controllers developed, communications between controllers also developed. And as facilities incorporated distributed controllers within the structure of the security electronic systems, communication networks were installed to support the specific requirements of the controller.

Networks were and are presently required to provide communication links between equipment nodes. Networks are typically required for the programmable logic controllers, video switches, access control systems, microprocessor-controlled intercom systems, electronic perimeter detection systems and other security systems. From the early 1970s to the late 1980s, networks were generally structured with metallic conductors and the data communication rates were relatively low.

Significant changes have occurred during the past decade regarding networks. The primary communications medium for linking network devices is currently the use of fiber-optic technology. This technology provides large bandwidths that directly support high-speed data transfer. In addition, fiber-optic transmission systems are immune to electromagnetic interference to which metallic conductors are subjected. As bandwidth has become available for the network, terminal devices that are connected to it have been enhanced to take advantage of the available bandwidth.

The development of the ethernet LAN has been a significant development and provides a common pathway of support for many of the security system components. System components have been developed and are continuing to be developed, which will interface to an ethernet LAN. The LAN communications often extend communications connectivity to a wide area network. Consideration must be given to the structure of the LAN to ensure that security functions are not compromised by unauthorized access to it.

It is common today for equipment to be LAN compatible. This capability facilitates the connectivity of system components and supports a high level of integration for the security equipment and their related functions.

Perimeter Detection Systems

Perimeter detection systems technology also was essentially nonexistent within correctional facilities in the early 1970s. The traditional perimeter security system during that time consisted of staffed towers located on the perimeter of the facility and a double-perimeter fence system.

By the mid-1970s, technology that had been developed primarily for defense activities was being declassified and was available for use at correctional facilities. There was generally a reluctance to remove the security staff from the towers; however, systems were installed to provide an opportunity to assess perimeter technology.

For some facilities, electronic perimeter detention systems supplemented the security provided by the staffed tower system. For many new facilities, detection systems were installed and security staff were located in vehicles that facilitated an immediate physical response to an alarm event.

Since the early 1970s, several of the technologies or systems designed for perimeter detection functions have been discontinued from production while new systems or products have been developed. Significant enhancements that have been realized in perimeter detection security equipments include signal processing enhancements, which improved the detection capabilities, reduced false alarms and enhanced diagnostics to support system setup and maintenance functions. Although there are correctional systems that do not use or limit the use of perimeter detection systems, the use of perimeter detection systems is common within a large number of correctional systems and has provided an effective means to enhance the perimeter security of a correctional facility.

Closed-Circuit Television Systems

Closed-circuit television systems in the 1970s generally consisted of monochrome cameras employing vidicon imaging tubes. The quality of the video was limited and the life of the vidicon imaging tube required frequent adjustments and tube replacement. In addition, system applications were limited to dedicated video links between a specific camera and

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video monitor. Also, there was little equipment available to effect video switching, which would facilitate switching a single camera to multiple video monitors.

However, several significant technological advancements occurred in the 1980s. One was the development of closed-circuit television system cameras employing a solid state imaging device in lieu of the vidicon tube device. The initial solid state imaging devices were for monochrome applications. By the late 1980s/early 1990s, solid state closed-circuit television system cameras were available, which incorporated color imaging devices. Today, the quality of the video camera and its video image has increased significantly over cameras of the past decade, and the cost of the cameras has significantly reduced.

The development of video matrix switchers employing microprocessor controllers has facilitated the increased use of closed-circuit television system cameras within a correctional facility. The switchers provide a means to route a video image from a closed-circuit television system camera to multiple locations in an efficient manner.

Today, significant interest is being directed by the closed-circuit television systems industry to effect video communications between a closed-circuit television system camera and the video monitoring location via the Internet. The specific video system application will significantly impact the video communications system and the process for controlling video switching functions.

Video Recorders

Recording of closed-circuit television systems video was not common in the early to mid-1970s. However, by the late 1970s/early 1980s, the industry responded to video recording requirements with video cassette recorders. By the mid-1980s, the VHS recording format was deemed the dominant format and video recorders were integrated into the closed-circuit television systems. Due to the large bandwidth requirements of video signals and the limited storage capacity of VHS tapes, video recording systems for many cameras were expensive and logistically difficult to manage with regard to tape management and storage. By the late 1990s, significant development had been made regarding storage of video images employing digital techniques in lieu of the analog techniques of the VHS recorder systems.

Digital video recorders provided a means to store video on high-density hard drives, which provided high-speed access to the stored video and, thus, significantly reduced the time required to retrieve video information for review. Digital video recorders provided a means to communicate video images from the digital video recorder's hard drive to a monitoring or viewing location via an ethernet LAN. Software features of current digital video recorder units allow the user to selectively program recording parameters on a per-camera basis, such as the record frame rate and video resolution, and to modify these parameters on a dynamic basis as dictated by the application requirements.

Significant reductions in recording costs have been realized during the past several years and it is anticipated that there will be further cost reductions and increases in the performance of digital video recorders. With the development of closed-circuit television cameras equipped with Internet capability, the use of a personal computer with high-capacity storage units may be used to store and retrieve video images in lieu of the packaged digital video recorder for selective applications.

Access Control Systems

In the 1970s, access control technology applications[2] within a correctional facility were limited. Reader technology was primarily the magnetic card type. By the early 1980s, card readers were developed that employed proximity technology. This technology provided a higher security level than most magnetic card systems, and the readers were less prone to vandalism than the magnetic card readers.

In addition to card reader technology, development efforts were directed toward biometric readers, which could be integrated within the access control system. Biometric devices development includes readers based on hand geometry, retina patterns, iris patterns, facial patterns and fingerprints. These technologies provide opportunities to select access control devices as required to support the security objectives of a correctional facility.

Technology's Impact

Technological developments as related to control systems, operator interfaces, networks, perimeter detection systems, closed-circuit television systems, video recorders and access control systems have significantly impacted the structure and functional performance characteristics of electronic security systems for correctional facilities. Current technologies enhance the integration of security systems to achieve operational effectiveness and provide for a more secure environment for correctional staff than was realized in correctional facilities of the 1970s and 1980s. Technology is constantly in a state of development and, therefore, provides a continuing challenge to those entrusted with the responsibilities to select and integrate the appropriate technologies into new or renovated correctional facilities.

ENDNOTES

[1] For purposes of this article, controllers are those system components that provide monitoring and control functions for the security systems.

[2] For purposes of this article, access control systems are defined as those systems that employ card readers, key pads and biometric readers as devices for facilitating access to a space or area.

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