Microcircuit Technology in the Maritime Industry

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With the increasing interchange of marine equipment within and among transportation modes, there is a great need to provide for better equipment control. Automated identification of equipment can play an integral role in filling that need. One group consisting of U.S. flag steamship operators and the Maritime Administration, the Cargo Handling Cooperative Program, has taken significant strides toward implementation of new technologies for automated equipment identification. However, a major hurdle lies ahead: the establishment of performance standards consistent with the needs of all future users in all transportation modes.

The trend in coding is toward miniaturization. The use of microencoding will permit assignment of a unique number to any product—be it automobile or caviar—if its value warrants tracking in a plant or across the country. Within the next 10 years, such product coding will be commonplace and standardized. This prediction was made in the fall of 1972. As the spring of 1986 approaches we see the accuracy of the prediction in all areas except that of standardization. Microcircuit technology has reached a level of maturity where automatic identification systems can permit the assignment of a unique number, and tracking can take place in even the harshest environments. However, little has been done in terms of standardization. Without standardization the true benefits of automatic equipment identification (AEI) will not be realized.

WHAT IS AUTOMATED IDENTIFICATION?

Automatic identification systems combine machine readable encoding of goods in process and reading by strategically deployed code readers for purposes of tracking, movement control, or accounting. All code-reading systems share the following features:

- First a product, part, component, package, pallet, tote box, or container whose accurate identification while moving into or through production, warehousing, or distribution will contribute to higher throughput, lower labor cost, more efficient handling, increased security, more accurate audit sales, or some combination of them all.
- A code that, when affixed to the product, can be automatically read and identified in terms of what the product is, where it came from, where or to whom it is going, or whatever else might be meaningful to the user.
- A fixed beam, a moving beam for the hand-held bar code reader, an optical character reader, a mag strike reader, a vision system, a surface acoustic wave reader, or a radio frequency interrogator will read the code and translate it into the system for meaningful control for information output.
- Finally, relays, solenoids, microprocessors, programmable controllers, minicomputers, divertors, counters, video displays, horns, bells, whistles, or other devices to control an operation are alerted by the code reader.

WHY AUTOMATIC IDENTIFICATION?

About the time of the great depression initial patents covering the use of optical sensors for automatic package sorting were issued in Switzerland. For the next 30 years the primary focus of identification technology was in the area of direct machine control—from conveyer line sorting to automatic bobbin replenishment in textile mills. The justification for such systems was invariably based on labor cost production. In the late 1960s railroad and marine terminal operators around the world enthusiastically evaluated optical systems for automatic equipment identification and the grocery industry launched its initiative to automate supermarket checkout. Although labor saving formed a basis for justification of these efforts, the pioneers saw significant additional potential in these systems that, for the first time, permitted item identification by a unique multidigit item number. The main thrust of the rail and marine industry program was improved utilization of equipment through better visibility. That of the grocery industry was tighter control of inventories, stock replenishment, and security at the checkout stands. In 1969 Volkswagen installed a white light moving beam scanner to count major automotive components moving along an overhead conveyer line. In 1971 the Buick Division of General Motors installed the first laser scanning system to count various transmission types as they moved from production to shipping. Again, labor cost production was the justification for both purchases. The significant payoff came from improved visibility, discipline, and control of line operations.

More has been written on productivity in the last several years, I suspect, than at any other time since the dawn of civilization. The marine industry has worked hard to maximize productivity gains, controlling equipment better from origin to destination. Tighter control has led to faster ship turnaround, improved resource utilization, lower inventory assessment, and reduced costs. These are not new concepts. Their mastery, however, has become critical to survival for most. The host of new technologies
designed to control equipment and to move that equipment more quickly and with less direct and indirect labor involvement is only part of the solution.

In the maritime industry, a simple reduction in time per container move may well be counterproductive without enhancement of the discipline and control of that container. System discipline trades heavily on the timeliness and accuracy of operations feedback. "Morning after" production reports are historical not preventive. The best decision making is done on the basis of feedback on events as, not after, they occur. It follows, then, that to achieve greater productivity, intermodal systems must provide discipline and control based not only on plans and performance goals but also on the dynamics of the actual operation. During the past decade, automatic identification systems have emerged as a major source of the real-time feedback that permits management to monitor and automatically control ongoing operations before they affect throughput.

Bar code and optical character recognition are two automatic identification systems that have been tested in the marine environment. They have been proven to be environmentally sensitive and application restrictive. They do not justify the significant financial investment required to support an equipment control system for the maritime industry. These tests helped the industry better define the specific requirements for a system that would provide real-time identification of all marine equipment.

Microcircuit systems (Figure 1) may meet the industry's requirements. Among other objectives, the microcircuit automatic identification systems were developed to address the environmental issues faced by marine operators. The systems are ideally suited for operation in a harsh, outdoor environment. Non-conductive materials such as grime, snow, and rain, which intrude between the interrogator and transponder, do not appear to affect operation of the system. The readers or antennas can be buried beneath asphalt to keep them free from vandalism, accident, and weather. The tags are rugged and not affected by dirt, and the life of the equipment is estimated to be more than 10 years.

Even when the cost and technical issues related to automatic identification have been addressed, one major barrier will still remain--that of standardization. We are rapidly approaching the time when standards for AEI will be essential. In the maritime industry, the benefits of AEI would be significantly reduced if each carrier's system were not compatible. To achieve the maximum benefit from the technology it is necessary to have compatibility among transportation modes and between the public and private sectors. The maritime industry has unique operational requirements distinct from those of the rail and trucking industry, and others are common to all modes. These all must be addressed.

CURRENT TESTING

Several organizations are currently testing the radio frequency (RF) technology for automatic vehicle identification applications. A group of mainly western states and Canadian provinces is evaluating RF technology for use as a heavy vehicle electronic license plate (HELP). Some railroads are testing the technology for automatic car identification. Many transportation authorities are evaluating RF technology for automatic toll collection. Probably the most extensive test in a transportation environment is the one being conducted by the Cargo Handling Cooperative Program (CHCP).

CHCP Testing

The purpose of the CHCP test is to conduct a comprehensive evaluation of RF technology and its applicability in the commercial maritime industry, including the intermodal application. To accomplish this goal, the CHCP is conducting a series of tests and analyses of the technology--some in operating terminal environments, some in controlled settings, others in the laboratory. The results of all of the tests will form the baseline of recommendation detailing maritime applications, vendor capability implementation concerns, and the potential for cost savings and productivity improvement.

Specifically, the CHCP testing is designed to answer questions about the technology and its implementation in the following areas:

* Reliability--the ability of the equipment to operate as advertised in the harsh environment of a marine terminal. The accuracy level of the equipment and the level of confidence with which it can be relied on as an integral component of a management information system.

* Maintainability--the ability of the system to operate unsupervised and the minimum frequency of required maintenance. The ability of current industry personnel to perform the required maintenance, annual
maintenance costs, and responsiveness of vendor personnel.

- Vendors and products—the range of vendors and products available now and in the near future. An evaluation of the stability of the vendors and the capabilities of their products. The trends in the development of the RF technology.
- Environmental—the effects of extreme heat or cold on the system. The ability to withstand precipitation, salt water spray, and the overall harshness of the marine environment.
- Applications—the identification of potential applications of the technology, including terminal gate, yard, apron, container freight station, maintenance and repair, and intermodal interchange facilities, and the potential gains from each application. The analysis of issues pertinent to each application.
- Utility—the ability of current personnel to interact with the equipment as necessary, and the ease with which the RF technology can be integrated into current industry systems.
- Tag location and application—the analysis and recommendation of the single best tag location such that all potential applications of the technology can be served by one tag per container. The recommended method of affixing the tag and its ability to survive in the recommended location or locations.
- Antenna locations—the recommendation of antenna locations for each application. The ability of antennas to withstand the requirements of different locations, such as buried beneath asphalt or attached to a mobile vehicle.
- Field programmability—the ability of tags to be encoded on site. The requirement for this capability and the potential for cost savings by employing the capability.
- Read-write capability—the requirements of the read-write tags and their potential applicability in the commercial maritime industry.
- Speed and distance—the minimum and maximum speeds and distances at which tags can be read. The speed and distance capabilities when reading from moving vehicles.
- Standardization requirements—the necessary worldwide transportation industry standards and recommended specifications.
- Automatic data processing system requirements—the level of effort and costs associated with developing software to support the technology. The pros and cons of requirements such as look-up tables and prepositioned data bases.
- Costs—an itemization of life-cycle costs of implementing the system, including equipment, system development, and maintenance. The anticipated cost savings associated with each application.
- Interference—the potential for interference between the system and the other electromagnetic devices.
- Security—actions needed to maintain the integrity of the equipment including those designed to avoid misuse, tampering, or unauthorized access.
- Tag data requirements—the recommended data elements on a tag needed for all potential applications.
- Implementation requirements—recommendations and alternatives for other considerations such as handling leased and customer containers, identifying containers in reversible lanes, and mounting tags and antennas.

To accomplish the objectives, the CHCP is undertaking a series of tests, defined hereafter, each designed to address one or more of the issues. The tests are specifically designed such that, by combining the results of each test, comprehensive recommendations concerning the use of RF technology in the commercial maritime industry can be supported. The following CHCP tests are under way:

- Puerto Rico Maritime Shipping Authority (PRMSA)—field test in Elizabeth, New Jersey, of a system to identify refrigerated containers as they enter or leave the facility.
- Matson Terminals, Inc.—field test in Oakland, California, of a system to identify chassis and motor generator (MG) sets at all 10 gate lanes. The reading antennas are buried beneath asphalt.
- Military Ocean Terminal, Bay Area (MOTBA)—field test both container identification and manifest generation in Oakland, California.
- Laboratory test—acquire definitive results relative to the durability and operability of available hardware.

Other laboratory testing—demonstrations and tests of the equipment in "live" but controlled environments, including test reads from a crane, test reads with alternative tag locations, controlled tests of selected applications, shock tests, and temperature testing.

STANDARDIZATION

If RF technology can be proven to be economically viable, there can be a tremendous impact on the transportation industry. Imagine immediately and automatically knowing a ship's manifest as the last container is placed on board, validating a train's consist as it speeds by, or just knowing precisely the location of cargo or equipment at all times. Interchanged equipment can also be automatically accounted for providing shippers and lessors with immediate knowledge of the carrier and location of a piece of equipment or cargo.

In the future, stopping at scales, for tolls, or at any other existing bottleneck may be eliminated by the ability to rapidly move equipment with the requisite discipline and control. However, we have reached the time when performance standards for the automatic identification equipment are essential.

Bar code vendors and users banded together several years ago to establish equipment and label standards. For most industries, there is one bar coding schema adopted by all parties. The transportation industry would be wise to follow some of the procedures established by the bar code industry and to learn from their success.

In the United States, the American National Standards Institute (ANSI) is the organization that must approve an automatic identification standard. Before a standard is approved by ANSI, it must be developed in such a way as to demonstrate evidence of national consensus. Standards developers must adhere to the criteria for due process established by ANSI. ANSI recognizes three methods for developing evidence of consensus for approval of American national standards, all of which are considered to be equivalent in the final results. These methods are:

- Accredited organization method: Using this method, a standards writing organization (e.g., ASME, EIA, IEEE) must develop operating procedures that comply with the ANSI requirements. Standards are generally drafted at the subcommittee or working group level, and evidence of consensus is achieved via voting by a standards committee or board, composed of directly and materially affected parties, within the organization.
- Accredited standards committee method: A standards committee (e.g., B11, T1, X3) is composed
of its members and secretariat. The membership must be sufficiently diverse to ensure a reasonable balance without dominance of a single interest category. The vote of the committee, itself, serves to provide evidence of consensus for the document.

• Accredited canvass method: Using the canvass method, a sponsoring organization (e.g., RIA, UL) develops a proposed American national standard and prepares a balanced list of interested parties (e.g., companies, government agencies, individuals, organizations) to canvass in order to develop evidence of consensus for the document. The sponsor then conducts the canvass in accordance with ANSI procedures.

Standards developers using any of these three methods must become accredited by ANSI before formally submitting a proposed standard for approval. To initiate the accreditation process, a standards developer submits an application for accreditation using the appropriate method or methods along with its operating procedure. The procedures are reviewed and a statement is prepared regarding compliance with ANSI requirements. The application is forwarded to the Board of Standards Review and the appropriate standards board or boards for comment. Finally, the application, along with all appropriate documentation, is submitted to the Executive Standards Council for consideration.

This seemingly circuitous procedure can take as little as 3 to 4 months after the standard is developed. A critical factor in the speed with which a standard is developed and approved is the accredited organization that is acting as its sponsor. The more experienced and committed the sponsor the faster the process.

The development of an American national standard for AEI will be a major undertaking. I would like to recommend here today that all interested parties attend a meeting that I have organized with ANSI in New York in April to begin evaluating requirements for standard development.