Do **you** know **where** your **boxcar** is?

AEI lets the Belt Railway of Chicago and other railroads answer 'yes'

By Sean Graham-White
Photos by the Author

Imagine you own a business in, say, Chicago, that ships products by rail. At some point, you might be curious as to where one of your shipments is and when it will reach its destination. You call Bill, your customer service representative at the XYZ Railway, which serves your business, and ask where car ZMYX 12345 is, the boxcar carrying the load in question. Bill turns to his computer, taps a few keys, and tells you ZMYX 12345 arrived in Tulsa, Okla., two days ago at 3:34 p.m., was transferred to the AB&C Railroad yard at 9:14 a.m. yesterday, and put into AB&C train 18, the local to Oklahoma City, at 3:46 this morning. "It should be at its destination this afternoon," Bill says.

Wow! Ain't technology wonderful? It's getting that way for shippers who need real-time data on where their shipments are, thanks to advances in computer technology and the advent of Automatic Equipment Identification, or AEI. This means of obtaining data relies on scanners along the tracks which read information located in tags mounted on each piece of rolling stock. Since the information scanned is transmitted directly into a computer database that tracks the tag locations, accurate updates are provided more quickly than ever before. With more than a million cars and locomotives on North American railroads, it's easy to see why being able to accurately pinpoint the location of a particular boxcar or grain hopper might be important. Being able to tell a customer where a shipment is has always been an important part of a railroad's business, and today it seems customer service is more important than ever.

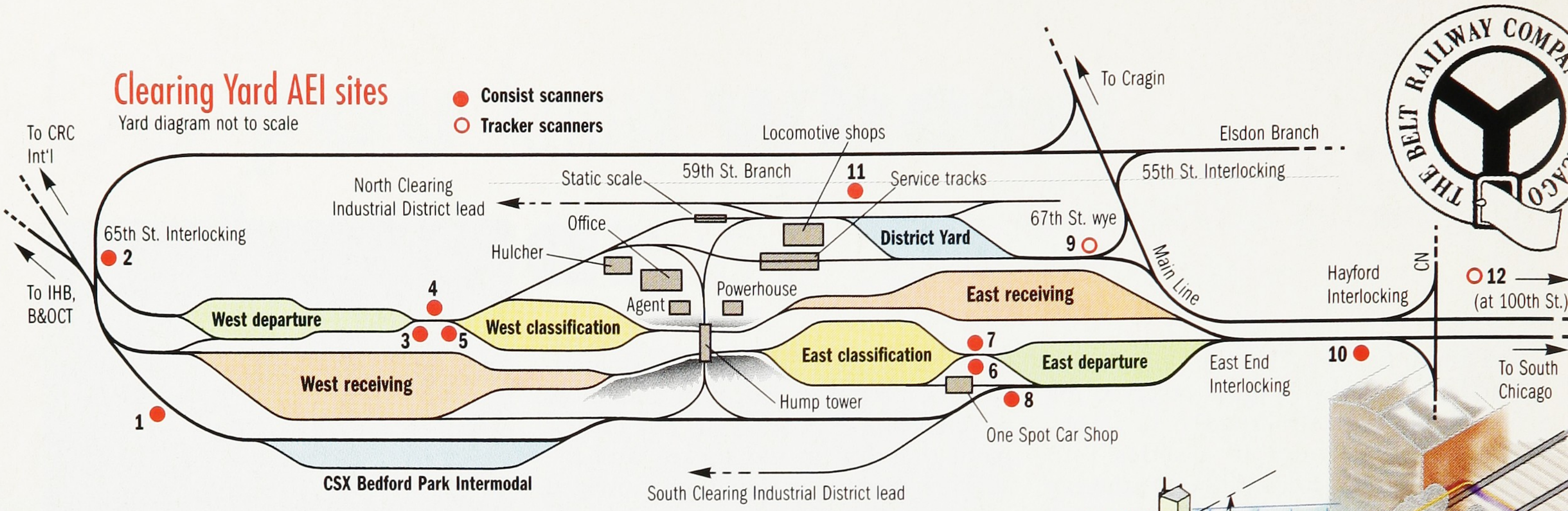
Taming the letters and numbers

Almost everything that rolls on rails has a unique set of identifying letters and numbers called a reporting mark. Letters in the reporting marks range from two to four—for example, WC for Wisconsin Central, KCS for Kansas City Southern, BNSF for Burlington Northern Santa Fe, or UTLX for Union Tank Car Co., with the X suffix reserved for "private" (i.e, non-railroad) car owners. Numbers can range in a series 1 to 999,999. Initials are assigned to the car owner by the Association of American Railroads, while the number series is assigned by the owner by type of car. For example, the reporting mark UP 249039 is assigned to a gondola with removable covers designed to carry coiled steel. Whenever someone wants to find this car, they use that information to locate it in a variety of ways.

The idea of automatically tracking railroad cars isn't new. Until AEI, the most notable tracking system was ACI—Automatic Car Identification—introduced nationally in the early '70's. Large colored bar codes, similar to those on products in grocery and other stores, were placed on rolling stock. After a train passed a trackside scanner, a printout of the train consist would automatically be prepared. But rain and snow affected ACI's accuracy, as did dirt or paint that got on the sticker, and the stickers themselves could get damaged or even removed from the car. A larger problem was that ACI was not integrated with any computer systems—it only gave a printout for an individual ACI scanner. As trains passed, ACI scanner printers spewed forth, but over time, the accumulated paperwork was ignored. As components failed and cars got dirtier, no action was taken to fix the system since no one was using it anyway. By the end of the '70's, ACI was dead.

AEI, however, relies on a small tag

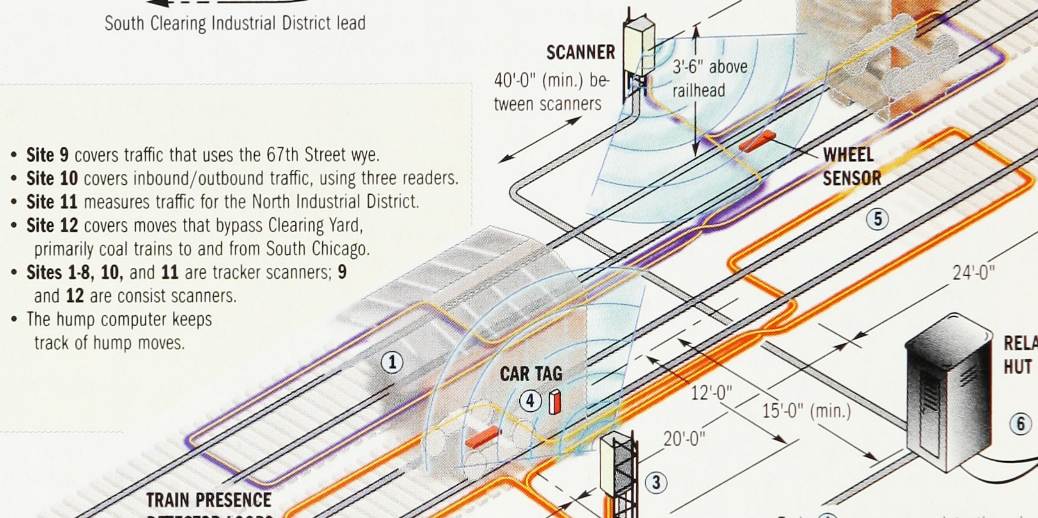
Automatic Equipment Identification "readers" can be configured to scan cars in trains moving at road speed and in yards. The scanners read electronic "tags" which may be mounted high or low on the side of a car, depending on type.



AEI in action at Clearing Yard

For more than two decades the BRC has relied on 10 camera installations to provide train movement information. AEI installations started to appear in 1966; By the end of 1997, 12 different sites covered 24 tracks. Looking at the diagram of Clearing Yard above:

- **Sites 1, 3, 4, 5, 6, 7,** and **10** employ both cameras and AEI.
- **Site 1** is inbound and outbound traffic off the Indiana Harbor Belt and the 59th Street branch.
- **Site 2** covers outbound traffic that uses the 59th Street branch.
- **Site 8** measures traffic headed for the South Industrial District and the One Spot Car Shop, as well as intermodal traffic headed to CSX's Bedford Park Yard (AEI counts the railcars, not the containers or trailers).
- **Site 9** covers traffic that uses the 67th Street wye.
- **Site 10** covers inbound/outbound traffic, using three readers.
- **Site 11** measures traffic for the North Industrial District.
- **Site 12** covers moves that bypass Clearing Yard, primarily coal trains to and from South Chicago.
- **Sites 1-8, 10,** and **11** are tracker scanners; **9** and **12** are consist scanners.
- The hump computer keeps track of hump moves.



Train (1), passes over detection wire loop (2), activating RF transmitter (3) which bounces radio waves off car tags, (4). Once train clears presence detector (5), data is sent (6), to FEP at headquarters for processing.

attached to each side of the car that stores information electronically. Data in the tag includes the car's reporting mark, size, and type. The tags are "read" by trackside scanners, which come in two types: consist and tracker. A consist scanner, typically used along main lines, scans as a train goes by and waits for it to completely clear before sending the data to a host computer. A tracker scanner, designed for yard use, is better able to handle switching, or back-and-forth movement. The scanners are activated by the train passing over a "presence detector," essentially a large, figure-8 loop of wire on the track ties. To "read" the tags, scanners transmit a radio signal, which hits the tag, and information in the tag bounces back to the scanner. Once the train clears the presence detector, the data received from the tags is transmitted to a Front End Processor (FEP), where the information is translated into the makeup of the train. The consist is then sent to the host computer which further cleans up the data and then adds it to the database of information regarding car movements.

AEI on the BRC

Since AEI's introduction in the early 1990's, more than 1000 scanners have been installed across North America and millions of tags have been applied to cars. While the use of AEI has become common along main lines, it hasn't within yards. The Belt Railway Company of Chicago (BRC) is the first railroad to try it, installing scanners to track the movement of more than a million cars a year through its Clearing Yard southwest of Chicago. While the importance of being able to track cars between terminals is easy to understand, why is it necessary to track cars within a single yard? Despite its small size, the 43-mile BRC is an extremely busy railroad. While it serves many industries, it's also a bridge railroad interchanging with every major railroad that enters Chicago. Some trains travel over BRC's tracks as run-throughs from point-to-point, but most enter Clearing Yard where they are broken down on the hump and classified into new trains that depart on different railroads. Not only is the time that those cars spend in Clearing critical, but so is maintaining accurate records of when cars arrived, were humped, pulled down to departure yards, and sent out. Efficiency is the name of the game, and AEI allows BRC to keep track of a car's every move.

Because of the large number of railroads it deals with daily, BRC is always looking for the most reliable, efficient, and accurate means for keeping track of the cars entering its property. Formerly, the easiest way to keep track of a train was for a clerk to write down every car, on every train, in order, by hand. While this may not seem too hard, try doing it in the dead of night in the rain or freezing cold—then go back inside and try to read your own handwriting! Errors, of course, crept into the paperwork.

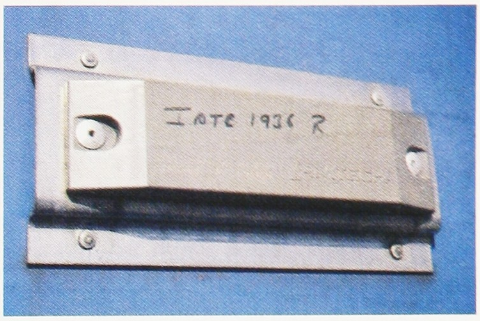
In the 1970's, things improved as BRC installed a video camera system to record each inbound train on videotape. Clerks could watch the tape and verify reporting marks of the cars against train lists from the inbound train crews. These inbound train lists were updated as necessary to make sure they were accurate. After the cars were classified on the hump and new trains departed, clerks again reviewed tapes and verified consists. Electronic Data Interchange (EDI) made things easier and more accurate a few years later through electronic receipt and transmission of train lists via computer. While EDI improved things considerably, it still had shortcomings: pick-ups or set-outs of cars en route often were not noted, sometimes the list would arrive as two separate trains when it was actually one (or vice-versa), glitches in other railroads' computer systems led to accuracy problems, and sometimes an EDI list wasn't received at all.

Operationally, AEI scanners allow more flexibility because one scanner is assigned to each track, whereas the cameras cover more than one track and an effort has to be made not to block sight lines when recording moves. Since the AEI system at the Belt is still fairly new, the cameras serve as a backup. When installed, the camera system was promised as 97 percent accurate. AEI's accuracy was promised at 98 to 99 percent, provided *all* cars have tags. To ensure interoperability, the Federal Railroad Administration mandated tags be installed on every car used in interchange by the end of 1995. Based on its AEI results, the Belt has found that 92 percent of freight cars have a tag on each side of the car, 5 percent are improperly tagged (mounted too high or low, blocked by a sill, only one side has a tag, tags on each side are mismatched, etc.), and 3 percent still have no tags. The 8 percent that isn't properly tagged enters the computer system with no reporting marks. This means the cars still have to be verified by camera or by physically finding them in the yard.

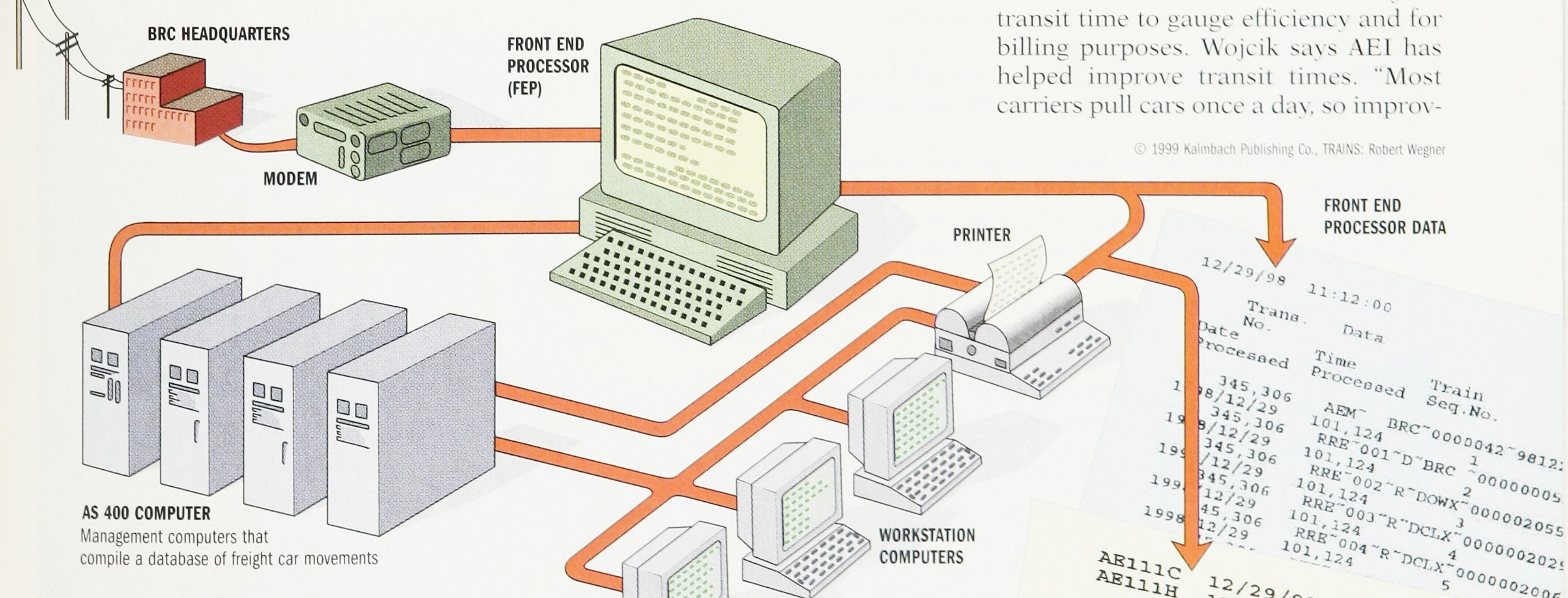
Despite this drawback, AEI has proven its worth thus far with its accuracy and ability to generate consist or switch lists quickly, about 3 to 5 minutes compared to 10 to 15 minutes using cameras. EDI lists from other railroads that use AEI have also become more accurate. Further, the aging camera system is becoming more expensive to maintain.

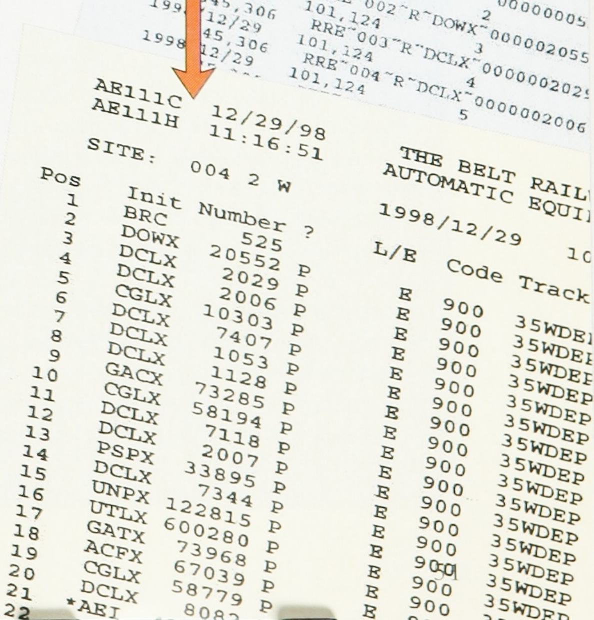
Cost savings have been realized since the introduction of technology with the reduction in clerks required to keep track of railroad cars. With just paperwork—handwritten reporting marks, and waybills brought to Clearing by inbound train crews—8 to 10 clerks were required. In addition, these positions were spread out across the yard, so it took time to get the information to other locations. When cameras were introduced, the number of clerks was reduced to six or seven, then five or six with EDI. During the same time all the clerks were moved to a central location. Now, with AEI, the number of clerks is down to five, while the total amount of time required to put together an accurate train list has been cut from two or three hours to only about one.

For the BRC, providing the customer with accurate, timely information is very important. Shippers demand immediate information. "They want to know where their car is and that it is routed and scheduled correctly," says Rod Wojcik, manager of agency and customer service. Each clerk has access to the computer system that handles the AEI database and can instantly index the requested car to verify information the shipper has requested. Customer Service Representative Kevin O'Malley has been with the Belt for six years and has found AEI a useful tool. He fields calls from customers all day long, especially regarding cars going to or coming from industries along the Belt. He uses AEI to tell when the car will be ready and on which outbound train it will be departing. "AEI gives us a better tool for timing and everything . . . from time of loading to time of departure," he says. Departure time is critical; BRC and the roads that use it measure yard transit time to gauge efficiency and for billing purposes. Wojcik says AEI has helped improve transit times. "Most carriers pull cars once a day, so improv-



Electronic "tags" carry information about the car they are mounted on. Reporting marks, and car type and size can be "read" by scanners.





AEI: many users many types

Integration of AEI into the North American rail system is improving the data used for scheduling trains as well as for answering customer queries. Nine railroads were surveyed during spring 1998 to see where they stood with regard to AEI implementation in terms of types and quantity of trackers used.

	Consist Reader	Tracker Reader	Scale Reader	Hotbox Detector	Wheel Impact Detector	Year Started	Future Readers	Notes
BNSF	308	1 (hump)	17	(1 test)	-	-	45	
ATSF	(33)	-	-	-	-	1992	-	Pre-merger qty.
BN	(150)	-	-	-	-	1989	-	Pre-merger qty.
CN	190	9 (hump)	-	-	6	1993	20	
CP	325	-	-	-	Yes	1993	4-5	
CR	218	-	5	(1 test)	-	1990	Yes	
CSX	236	-	-	-	-	1993	Yes	
IC	-	-	1	-	2	1994	Yes	
KCS	64	-	-	-	-	1992	10	
NS	184	95	-	-25	-25	1988	Yes	HBD/WID split
UP	600+	-	-	-	-	N/A	Yes	
CNW	(100)	-	-	-	-	1992	-	Pre-merger qty.
SP	(175)	-	-	-	-	1993	-	Pre-merger qty.

Additional scanner types in the chart and their uses:

- **Tracker readers** used at humps are used for consist verification.

- **Scale readers** feed directly into the railroad's computer system of cars which are weighed in motion, rather than having them weighed individually by a weigh master and then manually entered.

- **Hotbox detectors (HBD)** have been helping railroads detect overheated bearings on passing trains for years, but often their accuracy is off one or two cars and no specific axle or bearing is given. With the aid of AEI the detector can transmit the car reporting marks, the exact bearing that is overheating, and the position of the car in the train, saving the crew time in locating the car.

- **Wheel impact detectors (WID)** measure impact of a wheel on the rail at specific sites. If the impact exceeds specifications, potentially from flat spots on the wheels or shifted loads, the car is marked for set-out

These additional examples of readers show the new world of data that is potentially available. Most important, since much of the information acquired by the different types of defect detectors can be added to a centralized car maintenance database, preventive maintenance can be scheduled more efficiently.

Readers are not the only tools being developed and enhanced to aid the railroads. The tags themselves now come in a variety of types. In addition to the simple tags used on freight cars and intermodal equipment, there are battery-powered dynamic tags which can monitor conditions of the car or locomotive to which they are mounted. For example, Canadian National, Canadian Pacific, and CSX use dynamic tags to monitor fuel levels on some of their newest locomotives. Norfolk Southern does the same but also meters engine power. Union Pacific monitors fuel levels but also has scanners located at service facilities to monitor unit location and service time. One requirement for fuel monitoring on locomotives is that they be equipped with computers, so older locomotives can't take advantage of this technology.

Other uses for dynamic tags are monitoring fuel levels for the generator and internal temperature on mechanical refrigerator cars. Many railroads are looking at expanding the role of dynamic tags in the area of locomotive maintenance by adding water and oil pressure monitoring and other "health" information. Some act as car alarms that activate only when a load shifts, a door is opened, or when ride quality becomes dangerous or unacceptable. Battery-life for dynamic tags is about 8½ years.

—Sean Graham-White

ing turnaround can only go so far," adds Wojcik. "The crews who are departing on those trains have noticed the improved time it takes to get them their consist paperwork as well—they are no longer 'waiting on the clerks.'"

Making AEI work

While AEI is providing answers for BRC these days, it was a long journey to get there. It's relatively easy to obtain a read for a train passing on the main line, no matter what its speed. But in a yard, trains stop, back up, stop again, and go forward. Initially it was very hard for the computers to keep track of it all. While a consist scanner looks for "tag-tag-tag-tag . . ." as the cars pass by, a tracker looked for "axle-axle-tag-axle-axle-axle-axle-tag-axle-axle . . ." But there were problems. Because of multiple tracks with movement on many of them at once, radio waves tended to bounce through gaps between cars and read tags on cars on other tracks. These "bounced" reads would add to inaccuracy in consist reads.

Another problem relates to the very nature of yards: slow and back-and-forth movement. A switch move might leave a car sitting next to the scanner after moving past it in one direction. If that car moved past the scanner again in the other direction, there was the chance that the tag could be read a second time. Plus, since the scanner relied on axle spacing based on timing, that was no longer reliable due to speed changes or stops. The result was chaos.

To solve these problems Jim Zalumsky, manager of data development and communications systems, and Jan Tyrrell, senior programmer analyst, found themselves augmenting the Tracker software. "While AEI offers a yard operation many opportunities, in order to realize the advantages, the AEI system must be integrated into the yard's inventory and car-control systems," Zalumsky says. "Adding AEI scanners at the BRC's Clearing Yard was not a 'plug-and-play' installation. In order to get the tracker scanners working, we had to identify the differences between our yard installations and the common mainline sites. Only then was it possible to develop the necessary changes to the tracker sites, FEP, and host programs." In its improved form, the software uses passing axle timings to measure where proper tag locations are, then verifies this measurement by taking reads from the other side of the cars since both sides are tagged. In order to translate all this data, the FEP verifies it by reversing the consist (or raw data it receives) to check the timing of axles and tags. Once that is done, it sends it to the host computer which builds a complete consist from the bits and pieces the FEP sends it.

With AEI fully integrated into BRC's computer system, there are a lot of other end-users in addition to the clerks. Since the information obtained by AEI acts as a car-processing database, it can be used for revenue accounting, car-hire calculations, efficiency reports, and yard management. One innovative program developed by Zalumsky and Tyrrell is tracking end-of-train devices and generating reports on their movement into and out of the yard to prevent BRC from being questioned about either stealing them or passing them along to the wrong railroad. Overall, the BRC projects an annual savings of $200,000 by using AEI.

From the perspective of BRC and other railroads, a common theme regarding AEI emerges. More accurate information is acquired more quickly, resulting in better customer service and utilization of cars and locomotives. Better utilization means cost savings for the railroads, and better information means happier customers. The advantages that AEI have already proven are just the beginning. Railroads are still installing readers and more varied applications are being developed. I

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Belt Railway of Chicago is the first railroad to install a large-scale AEI system in a yard. Low- and high-level scanners (right) are activated by under-rail car presence detection loops (below).