A REAL-TIME WORK ORDER REPORTING SYSTEM FOR RAIL TRANSPORTATION: BENEFITS AND SYSTEM REQUIREMENTS

Randolph R. RESOR
Director, Pricing and Costing
Zeta-Tech Associates, Inc.
Cherry Hill, NJ, USA

Michael E. SMITH
Manager, ARES Traffic Planning Systems
Burlington Northern Railroad
Overland Park, KS USA

Pradeep K. PATEL
Senior Engineer
Zeta-Tech Associates, Inc.
Cherry Hill, NJ, USA

INTRODUCTION

Control of service quality in goods movement has been a major problem for railroads throughout the history of the industry. The complexities of railroad operations, especially in yards and terminals, produce random delays that are difficult to detect and impossible to correct after they have occurred. The result has typically been uncertainty about the location of in-transit shipments and enormous variances in transit times (a variance greater than the mean transit time is not uncommon on many North American railroads). Predictably, shippers have deserted the rail industry in large numbers. Although rail freight tonnage in North America has remained relatively constant over the last decade, shipments by truck have increased fivefold. More worrisome, railroads have been left with the low-revenue bulk traffic (coal, grain, ore) while truckers have taken the high-value commodities. Rail revenue per ton has fallen steadily, in both nominal and constant-dollar terms, since 1980.

Conventional railroad control systems cannot produce truck-competitive service quality in carload freight shipments. However, in recent years advances in computer hardware and software have made possible the development of "advanced train control systems". These systems, characterized by on-train computers linked by digital radio to a central station, provide vastly improved control through real-time communication between train crews and supervisory personnel.

This real-time control promises substantial benefits in terms of better service for railroad customers and better utilization of expensive railroad assets such as locomotives and cars. However, these benefits have a cost. The installation of the on-train computers and digital data links, and the development of necessary management software, will be expensive. Maximum benefits will be realized only through careful analysis of the required system functionality.

This paper will describe one possible configuration for a real-time work order system, outlining its functions, hardware requirements, and expected benefits.

1. DESCRIPTION: WORK ORDER SYSTEMS IN RAIL TRANSPORTATION

The term "work order" refers to the set of instructions provided by railroad management to each train crew. These instructions typically include a complete list of the cars on each crew's train (in consist order), along with notations as to what is to be done with each car (set out at a customer, delivery to interchange, set out enroute for transfer to another train, etc.). Special handling instructions for certain cars, notices regarding local conditions (tracks out of service, etc.), and even reminders about operating rules, may also be included. Train conductors have been provided with much of this information -- train consists ("wheel reports") and information on the destinations of individual cars ("waybills") -- for many years. But the purpose of a work order system is intended to provide all the information required by a train conductor, in a consistent format.

The development of computerized work order systems by railroads is the result of continuing pressure to reduce operating costs. Historically, clerks and station agents at dispersed locations handled paperwork such as customer billing, production of waybills and switch lists, and preparation of train consists. Centralization and computerization of these functions has greatly reduced the number of clerks and other employees. It has also required development of new ways to transmit required information to train crews.

The primary purpose of work order systems is to maintain up-to-date information on the location of all freight cars on the railroad. Freight cars can be in one of only three states: at a shipper's siding, on a train, or in a temporary storage location such as a yard or set-out track. Usually, separate databases are maintained for these three states, since payment of demurrage by shippers or "per diem" rentals by railroads depends upon a car's location.

These three databases are updated as train crews move cars from one state to another: for example, assembling cars in a yard into a train, and then spotting cars at each of several customers. Work orders, in conventional usage, are distinct from shipper requests for delivery or removal of cars. Each work order consists of multiple shipper service orders; these are assembled into a single work order for the train scheduled to serve those customers.

Once a train has been assembled in a yard, its work order will specify what is to be done with each car. There are only five activities a train crew perform:

- Spot a car for loading or unloading
- Pull a car from a loading or unloading location
- Move a car from one location to another within a customer facility
- Set a car out on line-of-road (for interchange, pickup by another train, or for "constructive placement")
- Pick a car up on line-of-road

Of course, unit bulk commodity trains and intermodal trains may perform none of these functions, remaining intact from origin to destination. In this case, the work order will simply identify the consist and indicate a destination. No customer-by-customer listing is necessary. But for a local train, the work order must list each customer to be worked, along with the car identification numbers for cars to be placed, pulled, or moved. A work order need contain no more information than car numbers, customer locations, and instructions to perform one of these five activities. At the completion of all work on the work order, the train has a revised consist.

The work order systems now in use by several North American railroads are similar in concept. Their purpose is to provide, in a single document, all the information a train crew will need to perform its daily functions. They differ in one important way, however. Some are "real time", using digital radio and on-board computers to transmit and revise work instructions in real time. Others rely on batch processing, generating a single work order for each crew at the beginning of a work day, and requiring the crew to return a completed work order to clerical personnel (in person or by telefax) at the conclusion of the day for entry into the system. Real-time systems are obviously far more flexible; however, the flexibility has a cost. The cost is the provision of an on-board computer and a digital radio link to provide communications capability.

Whether the capabilities of real-time systems are worth the cost is a major issue for railroads. If work orders are viewed solely as a cost-reduction measure, and service quality is deemed unimportant, there is little apparent value in providing real-time communications capability. But the recent emphasis by railroads on providing a quality product has generated interest in real-time work order systems as a tool to control service quality.

The work order systems implemented to date in North America are intended to cover all types of traffic and all types of trains; no train should operate without a work order on these railroads. However, work order reporting -- especially real-time work order reporting -- is clearly of greatest benefit in local and industry switching service. Trains which do not change consists en-route (coal and other bulk commodity "unit trains", intermodal trains) realize little benefit, either in cost reduction or improved service control, from use of a work order system. It is the time- and labor-intensive collection and distribution operations which should benefit most.

2. EXPECTED BENEFITS OF WORK ORDER SYSTEMS

The purpose of the work order system is to plan and schedule the work of train crews. However, it is not possible to schedule all work in advance, since it is impossible to perfectly predict future occurrences. However, the addition of unplanned work may mean delays to cars or train crews, since without advance knowledge of work to be done, crews may run out of time before completing all scheduled work and any additional work. Outbound connections in yards may also be missed if large volumes of additional work delay completion of a switching shift.

Real-time or near real-time information will reduce additional work, by reducing the volume of inaccurate or out-of-date information used in the generation of work orders. Since most additional work is performed by yard and industry switchers and local freights, the benefits resulting from a reduction in additional work will be realized mostly in these services. For this reason; the analysis presented here is confined to switchers and local freights. There simply do not seem to be large benefits to be realized from real-time reporting of train consist data and completed work by unit trains and through freight trains.

The four main areas of expected benefit from on-board reporting of work by crews are listed below. The benefit areas are as follows:

1) Reduced yard time for inbound cars, due to advance notice of consist and reduced time for consist verification
2) Quicker response to customer releases of cars, through enhanced ability to service late customer releases the same day they are received
3) Reduced yard time for outbound cars from local trains, through advance notice of consist and car destinations and through preblocking of cars to reduce switching
4) Better chance of making outbound connections

In addition, the use of work order systems will improve billing accuracy for demurrage and intra-plant switching.

In a small percentage of cases, cars incur extra handling in terminals due to incomplete or inaccurate information. In these cases, not only will car detention in yards be reduced, but the workload of switching crews will also be reduced. This will save both switching locomotives and crews. Preblocking of cars (made possible by timely and accurate information) may also reduce the switching workload.

The benefits analysis presented here is based on a study performed for a major North American freight railroad. Data and statistics in the analysis are actual data on the performance of an implemented (although not a real-time) work order system. Actual dollar savings are not stated here, since the cost data on which they are based is proprietary and confidential information. However, the discussion serves to illustrate the sources and magnitudes of benefits a railroad might anticipate.

Table 1 shows, in detail, the areas in which these savings are realized. The following sections explain how real-time or near-real-time information will enable railroads to save car days and switch engine hours.

2.1 Methodology for Benefit Determination -- Yard Time Savings

Yard time savings apply to both sides of the car cycle: loaded cars or empties inbound to customers, and outbound loads or empties for other destinations. The benefit does not appear to be symmetrical, however. Systems already in place on most North American railroads provide good information on inbound cars, so a savings of only one hour, on average, in yard processing time has been assumed. Many outbound cars, however, are picked up as additional (unscheduled) work or as "no-bill" cars at present. More timely information should reduce this number, resulting in much faster yard processing time. A three hour reduction in outbound yard time has been used to calculate benefits. The justification for these assumed savings is discussed below.

To quantify the savings from reduced yard delays, a probability function from the railroad's blocking and scheduling model was used. This function is a cumulative probability distribution calculated for each railroad yard from actual car movement data. This distribution can be used to determine the likelihood that a car will make the first scheduled outbound connection, given that the scheduled yard time (number of hours between arrival and <u>scheduled</u> departure) is known.

TABLE 1: AREAS OF BENEFIT, REAL-TIME WORK ORDER REPORTING

1. REDUCED CAR CYCLE TIME
- Advice to crew in near real time of car release by customer, after issuance of work order, increases likelihood of pickup by crew.
- Real-time reporting of scheduled and additional work increases car scheduling integrity and enhances planning.
- Improved movement through terminal.

2. REDUCTION IN EXTRA HANDLING OF CARS
- Advice to crew in near real-time of car release or switch request, after issuance of work order, may eliminate re-handling of affected cars if they at location being switched in original work order.
- Real time advice of cars not handled as directed.

3. REDUCTION IN CLERICAL EFFORT
- Elimination of clerical work associated with processing work orders, in most cases.

4. REDUCED SWITCHING HOURS
- Advice to crew in near real time of release or switch request by customer, after issuance of work order, may eliminate rehandling of cars.
- Real-time advice of cars not handled as directed
- Cars reported as additional work in real time will prevent posting of subsequent work instructions for performance by next shift
- Elimination of lost time due to crews checking with customer for work assignments.

5. MORE ACCURATE AND TIMELY REPORTING
- Work is processed through host car cycle database immediately upon conductor's report
- Elimination of need for clerk to interpret what conductor was reporting, or failed to report

6. ENHANCED PLANNING BY OPERATING SUPERVISORS
- Confirmation of work completed or work not performed in-
- Confirmation of work completed or work not performed increases reliability of car scheduling data. Work not performed, and reported in real time is available for inquiry, planning, and corrective action.

7. CUSTOMER SATISFACTION
- More timely car location data
- Better customer response time

8. MORE ACCURATE WORK ORDERS FOR TRAIN CREWS
- Work not performed is released for use on next shift's work order in advance of work order issuance.
- Unscheduled work reported in real time by conductor will remove work instructions from file, preventing issuance.

The assumption behind the analysis is that actual performance of freight trains varies around their schedules. Sometimes trains are early, sometimes trains are late, due to the random disturbances that occur in railroad operations. For each car moving on the railroad, there is a schedule that assumes certain train-to-train connections will be made. Sufficient time is allowed between scheduled arrival and scheduled departure in each yard so that, in theory, each car can make its schedule. In practice, a certain small percentage of cars never makes the schedule. For example, cars experience mechanical failures and are sent to the RIP track.

Most cars make schedule some percentage of the time. However, holding all other factors constant, the longer the time a car is scheduled to be in a yard between trains, the greater the probability that it will make its scheduled connection. Sometimes, the apparently paradoxical result is that a longer scheduled time in a yard results in a shorter average yard time for cars making the scheduled connection. This is because most connections are once-a-day events. If a car misses a scheduled connection, the minimum yard time until the next opportunity is 24 hours.

An example will clarify this point. Assume that, through use of improved train control (computer-aided dispatching or something similar) all trains systemwide arrive two hours ahead of schedule. Then every car on the system has two hours more to make its onward connections at each yard. The percentage of first outbound connections made increases (the actual increase will depend upon the shape of the cumulative probability function at each yard) and total yard time for all cars decreases, because fewer cars are missing connections and waiting at least 24 hours for the next opportunity. If more yard time becomes available (through earlier arrivals or more timely receipt of information), there is an increased probability that cars will make their scheduled connections.

Availability of detailed and accurate train consist information in real-time or near-real-time will reduce time required to verify inbound consists. Information from one North American railroad indicates that the minimum time to obtain inbound consist information is 30 minutes (and the information may not be entirely accurate). On-board work order reporting should reduce time required to verify consists. The consensus of those involved in the analysis presented here was that one hour per train might be saved (partially because cars will be available in enroute inventory sooner).

On the outbound side, on-board reporting of "pulls" by industry switchers may enable yardmasters to plan and schedule classifications and departures more efficiently. It may also be possible to schedule tighter connections. Since the impact of near-real-time information on outbound yard processing appears larger than that for inbound yard processing (where only consist verification is involved) a larger benefit has been assumed --three hours per train, as opposed to 30 minutes. The effect is as if trains arrived earlier, and thus connection probabilities are improved.

The benefits of reduced yard time for cars have been expressed in terms of car-days saved. If five percent more cars are assumed to make outbound connections as a result of better information, then the savings is 5% of total outbound cars times 24 hours per car (the time each car would have spent waiting for the next available outbound connection, if each destination was served by on train per day).

2.2 Methodology for Benefit Determination -- Improved Customer Response

A common problem observed during field visits to a number of North American rail terminals was the high frequency of "late" customer releases of cars (after local switchers were already on duty). While industry jobs may work days, evenings, or midnights, in all cases some customer calls are received after the jobs have already gone to work. These calls cannot show up on the crew's work order. They are handled, if at all, as additional, unscheduled work. If the late calls cannot be handled, shippers typically must wait an additional 24 hours for service (since most shippers are served at most once per day), and the railroad loses 24 hours' worth of demurrage payments (since demurrage stops as soon as a customer release of a car is received).

Customer calls releasing cars are not uniformly distributed over time. Since most customers do not work two or three shifts per day, the calls peak in late morning (these are probably releases of cars unloaded the previous day) and in late afternoon. Examination of actual railroad data from an implemented work order system confirmed this distribution.

Jobs working the day shift, beginning work between 6 a.m. and 8 a.m., currently cannot respond to many calls the same day. The work order given the crew will list calls received the previous afternoon. With luck, some cars released in the morning may be picked up as additional work. Afternoon jobs (starting between 3 and 6 p.m.) may be able to handle somewhat more same-day calls, if information can be logged quickly enough by clerks to appear in work orders.

With the capability to transmit work orders directly to crews, and for crews to report work as it is completed, clerks can amend outstanding work orders by adding late releases as the calls are received. Of course, there is a chance that an enroute crew may have passed the customer who has just released a car, but with frequent updates by crews, clerks can judge where the train is and decide whether or not to transit a revised work order.

To quantify the benefits of on-board reporting, it has been assumed that the "cutoff" for handling late calls within the work order system can be extended by four hours. Since industry switchers generally work eight-hour shifts, if calls are randomly distributed the switcher will, on average, be able to service half the late calls as it moves along its route. The other half will be from locations the switcher has already passed.

Car-day savings have been calculated based on the difference between the current noon cutoff and an assumed 4 p.m. cutoff. The 15% of cars now handled as additional work have been excluded, since it has been assumed that some late calls are handled as additional, unscheduled work at present.

2.3 Methodology for Benefits Determination -- Preblocking

A major possible benefit of on-board reporting of information in real-time or near-real-time is anticipated to be the ability of local switching jobs to "hold" blocks. At present, these jobs do not usually make blocks, since the number of cars to be handled, and the number of destinations for those cars, varies widely from day to day. With access to detail on intended destinations for cars, it should be possible for the switch crew to make at least one block per day, and hold this block intact for delivery either to a yard or to a set-out location.

At present, locals and industry switchers do not put inbound cars in order before arriving in the yard, so all cars must be classified. With one or two pre-established blocks, yarding of some cars might be avoided altogether if the blocks could be set out for pickup by a through train.

In theory, if the crew has waybills for cars they should be able to engage in some preblocking at present. Therefore, this benefit has been calculated only for cars handled as additional, unscheduled work (for which crews may not even have waybills). These cars constitute about 15% of total cars handled.

The average number of cars handled by local freights, industry switchers, and yard switchers on the studied railroad is 39 per shift. If half of these are outbound, and 15% are handled as additional, unscheduled work, three cars per shift that are not now preblocked might be preblocked if more information is available to crews. It has been assumed one car day can be saved for each of these cars. In addition to the car day savings (one day for 7.5% of cars), preblocking will also reduce the number of cars switched by the same 7.5%, since yard handling is assumed to be avoided altogether for these cars.

2.4 Additional Savings Areas

Although not quantified in this analysis, there are also expected to be clerical savings due to the use of on-board reporting, and efficiency gains due to the anticipated reduction in unscheduled work. In addition, more timely and accurate data will be available to clerks, supervision, and customers. Immediate confirmation of work completed, or not performed, will enhance the reliability of a railroad's car scheduling system.

Benefits also will accrue to railroads in the form of additional demurrage and intra-plant switching revenue, since (unlike present practice) accurate data will be available on customer releases of cars and requests for intra-plant switches. Currently, North American railroads suspect that they undercharge customers for both activities.

2.5 Conclusions of Benefits Analysis

2.5.1 Yard Time Reduction

The first benefit area is the expected time savings for inbound cars moving from road trains to local delivery. As mentioned previously, a one-hour reduction in yard processing time was assumed, and a probability analysis was used to quantify the reduction in average yard time for all cars. This reduction worked out to be about 4.5% across the entire railroad.

2.5.2. Reduction in time from customer release to pull

Customer calls to release cars are not uniformly distributed over time (as confirmed by a review of actual railroad data. Real-time or near-real-time information will allow a railroad to respond more effectively to late calls received after a local switcher has already departed to do industry work. For the reasons outlined in the previous section, it has been assumed that the availability of better information will extend the "cutoff" time for responding to calls by four hours.

The volume of cars handled as additional work (15%) has been excluded from the benefit, since it is assumed that these cars are now being pulled as a result of direct requests from customers to the train crew. Again, there is a reduction in the average time spent in yards.

2.5.3. Preblocking and improved train makeup

Real-time information will allow for the "preblocking" of cars by local and industry switchers. These preblocked cars can be set out on line of road for pickup by connecting trains, avoiding yards entirely.

It has been assumed (conservatively) that this benefit will only apply to cars handled as additional, unscheduled work, those about which the switching crews have no information at present and cannot therefore preblock.

From operations data, a 7.5% reduction in the number of cars switched in yards can be achieved. In addition, one car day will be saved for the same 7.5% of the cars handled by the railroad.

2.5.4. Reduction in outbound yard time

Again, as in benefit areas 1 and 2, it has been assumed that real-time or near-real-time information will reduce the time required in the yard to process outbound cars, through advance consist information. A composite probability curve has been used again to determine the expected reduction in average yard time. A savings of three hours has been projected, based on this data.

2.5.5. Other Benefits

Although not specifically quantified in this analysis, a reduction in work order exceptions is an important expected benefit. Work order exceptions occur when cars are not handled as directed by a work order system. There are a number of reasons why cars might not be handled as instructed, and some are unrelated to the quality of data received by train crews. However, some categories of exceptions may be reduced by on-board reporting and more timely information.

There are four categories of work order exceptions. Three may benefit from on-board reporting of work order information, as shown in Table 2:

TABLE 2: WORK ORDER EXCEPTIONS -- AREAS OF BENEFIT

Exception Category	Benefit from On-Board Reporting
NP -- not performed	Y
Handled Differently	Y**
NT -- not in train	N
NI -- not in industry	Y*

*May be time savings from crews not having to verify absence of car
**In some cases, may be time savings as well as switch engine hour savings

If a car is not in a train as scheduled, it is probably the result of a missed connection or a mechanical problem. If the car is not in industry as listed on the work order, it may have been picked up as additional work by an earlier train. Here, more current information could enable the train crew to avoid a stop to determine that the car was not, in fact, at the location indicated on the work order.

Work not performed is often the result of a crew running out of time. This often happens because of large quantities of unscheduled additional work. Better information should reduce the incidence of additional work and, indirectly, the incidence of work not performed.

Finally, cars are handled differently than instructed either because a crew is short on time or because it is physically impossible to place the cars as directed.

It has been determined that some benefit may be produced for nearly half the total work order exceptions, although some benefits may be small. Based on actual data from a North American railroad, almost 14% of exceptions (the sum of "reduction in handling" and "handled differently") are expected to produce both savings in car days and a reduction in handling.

Substantial car day savings may result from the reduction or elimination of some of these exceptions. For example, on one North American railroad there were 194,740 instances of scheduled pulls from customers "not performed" in 1990. If, as seems reasonable, each of these resulted in an additional delay of 24 hours before the car was moved, a total of 194,570 car days might be saved if work not performed had in fact been performed.

Some cars handled differently than instructed will have to be handled again in order to get them to the customer. This additional handling means additional work, and time, for a switching job. Actual railroad data indicate that at least 1.3% of the cars handled differently, and possibly as many as 14%, will require a second handling in order to reach their final destinations. Again, substantial savings may be possible.

3. SYSTEM DESIGN ISSUES -- REAL-TIME WORK ORDER REPORTING

A system such as the one described in the preceding benefits analysis will impose substantial demands on train crews and clerical personnel. While little of the information being reported and transmitted is new, the form and the frequency are very different than in traditional railroad practice. A substantial training effort will be required before such a system can be implemented.

Proper system design can reduce training requirements and render the system much easier to use. It can also make the equipment more durable.

3.1 User Interface Design

Two work order systems, both based on the Advanced Train Control System (ATCS) specifications developed by the Association of American Railroads (AAR) are under development by Canadian National Railways and Union Pacific Railway.

Both systems use modified "laptop" personal computers. The machines are installed on a flat surface in the locomotive cab, and the train conductor accesses the system via keyboard.

Burlington Northern's ARES will use two monitors and a set of "soft keys" (programmed function keys) whose functions change with the type of screen display. The displays will support both work order and train control functions. While the soft key approach is simpler for crews to use than the ATCS keyboard, voice radio transactions may be required to allow clerks at a central location to correct errors found by the train crew. The ATCS keyboard entry will require significantly more crew training than ARES, and may not provide the same data integrity due to the difficulty of edit checks on the remote systems.

A second problem is the display of information. Originally, Burlington Northern intended to supply printers on some locomotives to make hard copies of work in structions. However, printers require frequent maintenance, which can be difficult to provide on board locomotives. Burlington Northern, and the carriers implementing the ATCS-specification system, have decided to go with video displays. BN uses a pair of color displays, while the Union Pacific system relies on a standard laptop monochrome LCD-type screen.

3.2 Prototyping a Work Order System at Burlington Northern Railroad

Burlington Northern began their investigation into prototype work order systems as part of the development of a proprietary version of advanced train control known as the Advanced Railroad Electronics System (ARES). The work order portion of ARES consists of software contained in an on-board computer, making use of two on-board CRT displays with soft (programmable-function) keys. No keyboard is provided for train crew use. The BN software receives and processes data transmitted digitally from a control or dispatching center, displays that data on specific screens that can be called up by train crews, and processes crew input.

One screen available to crews is a simple listing of all the cars in their train. This list shows car number, car status (loaded/empty), car weight, and whether each car contains hazardous material (information required to comply with U.S. government regulations regarding car placement in trains). Another screen displays work to be performed by the crew at each location.

Train crews can report work done by pressing the "pick up complete" key for this screen, or the "set out complete" key, or both, as appropriate. There is no way to report exceptions (e.g., work scheduled but not performed). The original design concept for the system called for the handling of exceptions by voice radio. Crews were to contact train dispatchers or clerks to have necessary updates to displayed information entered into the system. However, new features are being tested in a second stage prototype, and these include a utility which will allow crews to handle exceptions directly, without resort to voice radio.

In the second-stage prototype, the functionality of the on-board user interface has been enhanced to allow for more flexibility in exception handling. For example, the crew may bring up a screen showing a list of all cars at a particular location. If the status of one of these cars has changed since the issuance of the original work order (e.g., an additional car must be picked up), the crew can use the function keys to identify the car by scrolling down the list of cars and highlighting the car or cars with changed status.

The second stage prototype also provides a revised operational concept for the office side of the system. A supervisor or clerk in the office will receive customer requests for service and enter them into a "service order" system. This system will generate a unique service order for each car movement, which will include a car number and a trip plan which identifies the day and time the movement will begin and end, and all trains on which the car is scheduled to move. Service orders will be "bundled" into train-specific work orders by the computer system. When a work order has been assembled and checked by office personnel, it is transmitted digitally to the appropriate train's on-board computer.

4. CONCLUSIONS

Real-time, computerized work order systems offer railroads the potential for reducing costs and, most importantly, improving service quality. Real-time reporting and intervention provide the capability for better management of the process of delivering railcars to, and collecting them from, customers. Improved management of the process, in turn, will reduce the physical assets (cars, locomotives, freight yards) required to provide service, and improve the quality of service by improving reliability and consistency.

Based our analysis, it would appear that a railroad can service a given level of demand with about 7.5% fewer cars if a real-time work order system is implemented. This is a very large savings; there are about 1.25 million freight cars in service in North America, representing an investment of at least $62,500,000,000. Estimated savings from reduced car ownership alone is in the range of $4.7 thousand million, for an industry with total annual revenues in the range of $30 thousand million (United States plus Canadian railroads).

A real-time work order system will also enable railroads to make full use of track and locomotive assets in yards and industries, and will therefore increase available capacity. Finally, railroads should be able to reduce billing problems resulting from inaccurate demurrage records, unbilled intra-plant switches, and the movement of "no-bill" cars.

These new systems are complex. Careful design will be required, to avoid overburdening operating employees. Reliable hardware must be chosen. The system must be accurate, as easy to use as possible, and offer virtually 100% reliability. These are difficult goals for any system to meet. But a functional, real-time work order system will "empower" train crews, giving them the tools to be effective customer contacts. Improvements in the reliability and consistency of rail service will open new markets. The results, for railroad profitability, will be substantial.