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LEADING WITHOUT BLEEDING: AN INFORMATION TECHNOLOGY CASE STUDY AT UNION PACIFIC RAILROAD

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ABSTRACT

In the railroad industry, the ability to assess damages to rail units in an accurate and timely manner is critical to the success and profits of a company. Accurate damage assessment of rail units also plays a key role in dispute resolution and negotiation with key vendors and suppliers (my.uprr.com/pub/dam-prev). This paper describes and presents information about Union Pacific Railroads (UPRR) and Science Applications International Corporations (SAIC) highly successful efforts in fully automating the data collection, inspection, assessment and reporting of damage claims to rail equipment. UPRR and SAIC used an innovative and highly creative approach to develop and implement the Automated Gate System (AGS) by integrating a portfolio of leading edge high resolution imaging and optical character recognition technologies. AGS is a unique and revolutionary system in the transportation industry and has yielded significant strategic and long-term benefits to the company. The reengineering efforts that preceded the development of the system have helped the company to sustain its position as a leader in the railroad industry.

INTRODUCTION

Union Pacific Corporation is one of North America's leading transportation, computer technology and logistics companies, with operations in all 50 United States, Canada and Mexico. With headquarters in Omaha, Nebraska, Union Pacific Corporation currently has over 52,000 employees, covers more than 36,000 miles of track in 23 states and has an annual payroll in excess of $3 billion. There are 1700 people in information technology alone with a budget of about $250 M. The company's web site at http://www.uprr.com provides a comprehensive corporate profile of the company.

Science Applications International Corporation is the nation's largest employee-owned research and engineering company, providing information technology and systems integration products and services to government and commercial customers. SAIC scientists and engineers work to solve complex technical problems in telecommunications, national security, health care, transportation, energy, the environment, and financial services. With annual revenues of $4.7 billion, SAIC and its subsidiaries have more than 38,000 employees at offices in more than 150 cities worldwide.

Intermodal units are critical for the sustained success of a railroad company and hence it is important to ensure that these units are in good working condition. As customers' demand more speedy and efficient transportation of goods, rail intermodal service — the movement of trailers or containers by rail and at least one other mode of transportation — is ideally suited to meet this demand. That is one of the reasons intermodal is the fastest growing segment of the railroad industry (my.uprr.com/pub/notes). Intermodal traffic has grown from 3 million trailers and containers in 1980 to 8.7 million in 1997 and accounts for more than 17 percent of rail revenues, second only to coal at 22 percent (www.aar.org). Intermodal transportation yields many powerful benefits (www.aar.org):

- **Fuel efficiency**. Rail intermodal service on average uses less than half as much fuel as highway transport to move the same shipment the same distance.

- **Convenience and partnerships**. Intermodal combines the door-to-door convenience of trucks with the long-haul economy of rail service. As a result, railroads, trucking companies and intermodal marketing companies are forming productive partnerships to combine the best of both modes.

- **Improved air quality**. Moving a ton of freight by rail instead of truck results in less than one-third the emissions into the air.

- **Reduced traffic congestion**. A single intermodal train can remove as many as 280 trucks from the highways.

- **Innovative technology**. Intermodal technology, such as double-stack trains (one container on top of another) permit one train with two crew members to remove up to 280 trucks from the highway, reduce pollution and save energy.

Railroad regulations require the inspection of all intermodal equipment (vans, containers, chassis) during yard entry and exit to ensure that damages to a unit are positively identified and charged to the responsible party ("Building the Systems…," 1999). This is a very critical step if the railroad is to recover damage claims assessed by equipment owners and also to win disputes regarding the timing and extent of damage.

In January of 1995, during a strategic planning exercise at the company, it became clear that there was room for improvement in the way the company managed and maintained its intermodal units. Reengineering current intermodal operational process and practices would help the company be more responsive to customer needs while increasing its operational efficiencies and profits. Due to increased global competitiveness, customers expected their transportation companies to be agile and responsive. After considerable discussion among top and middle management, the company established the following primary goals for the reengineering effort of intermodal operations:

- Increase data accuracy
- Reduce transaction processing time
- Increase the rate of collections from damage claims
- Increase accuracy of the damage inspection
- Decrease number of yard personnel

As the reengineering team began to look closely at the intermodal operations, it became evident that two processes were big bottlenecks in achieving desired efficiencies. These were the *ingate* (arrival of an intermodal unit at a given rail yard) and *outgate* (departure of an intermodal unit from a rail yard) processes. The process of manually assessing and recording damages was slow, cumbersome, and error-prone. Since damages were manually assessed by physical inspections at the terminal gate, damages to intermodal equipment were often missed or inaccurately recorded. To make matters worse, in many cases, it was difficult, if not impossible, to retrace the steps and correct the inaccuracies. Further, since all damages were recorded on a form and filed for future reference, it was impossible to make effective business decisions involving claims. Managers often had little or no knowledge of the nature of the claims and found it difficult to be proactive based on trends in filed claims. As the volume of railroad traffic continued to increase significantly and customers became more demanding, it became clear that this slow, labor-intensive and error-prone process needed to be changed. The company decided to completely automate the in-gate/outgate processes and thus AGS was born. Currently there are three AGS systems in place. Marion, Arkansas (outside of Memphis, TN), Mesquite, Texas, and Kansas City, Missouri. The fourth system will be installed in mid to late 2000 in Oakland, California.

HOW AGS WORKS

The basic function of the Automated Gate System (AGS) is to automate the data collection, inspection, assessment, and reporting processes at intermodal gates. This required the creative application and integration of a wide variety of information technologies. The AGS System Architecture utilizes three separate network paths to accomplish the large amount of throughput required for image transfer and image display.

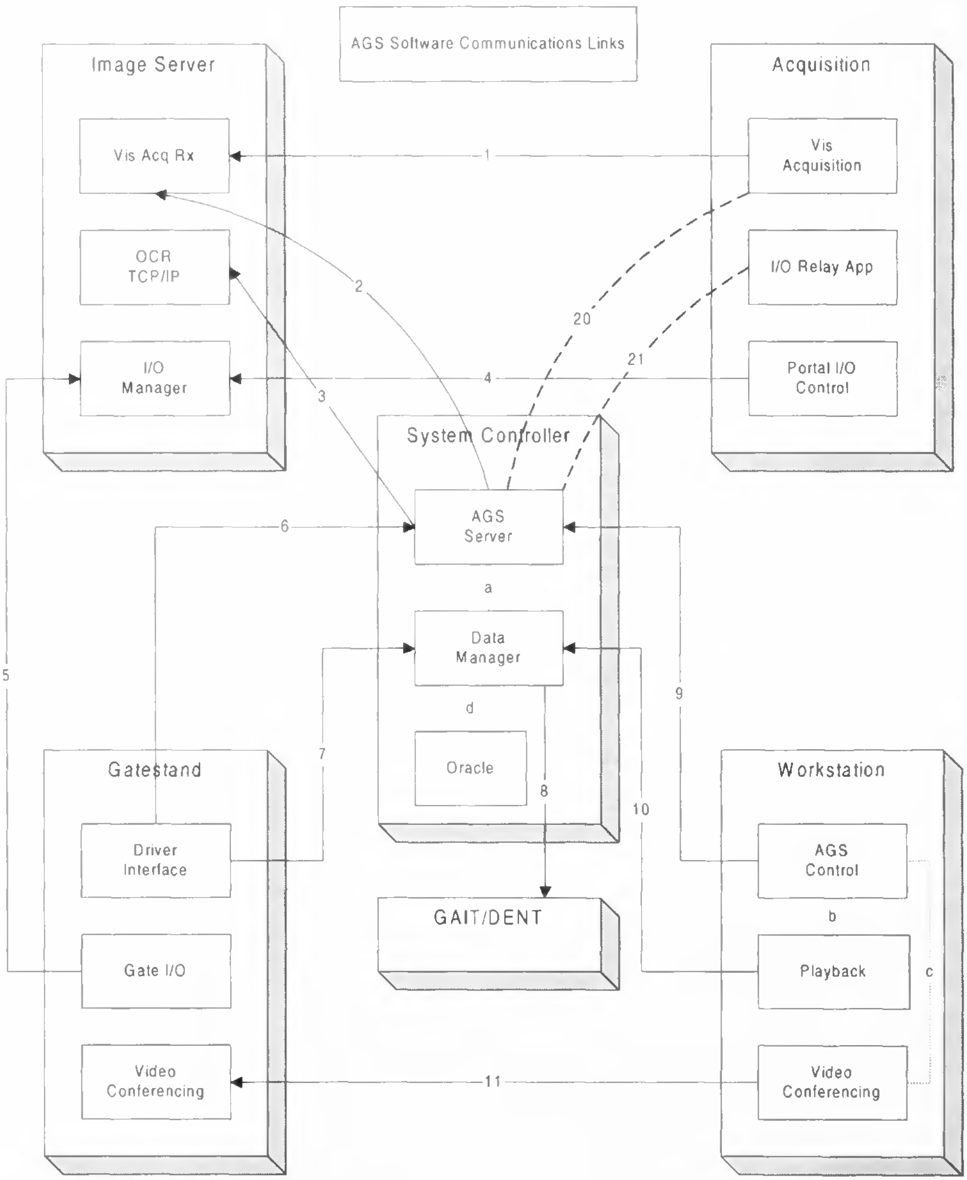
Although AGS is based on leading-edge technologies, (and some even bleeding-edge for its time), great leadership, outstanding project management, exemplary team work, a rigid discipline for organization, and a keen sense for detail has made AGS a remarkable success story in the transportation industry. At a cost of more than two million dollars and four years of development work, AGS has become a strategic information system for Union Pacific Railroads. AGS is the product of a number of technologies working together in an innovative and meaningful way. Figure 1 shows the subsystems that constitute AGS. The following section explains how AGS works.

Driver Enters Terminal

When an intermodal unit first arrives at a yard, it is guided by inductive loops embedded in the pavement at strategic locations in the yard. Live digital video conferencing technology facilitates communication between the AGS operator and the intermodal driver at the gate stand. For example, each gate stand in a rail yard has a

FIGURE 1

(This diagram shows the communications links between various applications. Numbered links are TCP/IP sockets; lettered links are Win32 messages.)



color video camera that displays a live image of the driver on the AGS workstation monitor. This image is captured as a digital snapshot and attached to the transaction images. Also, mounted directly to the rear of each gate stand lane is a two-way digital audio system that facilitates communication between the driver and the AGS operator when the driver is at the rear of the unit. Each gate stand has a call button to notify the AGS operator of the need to communicate verbally and this appears as a visual display on the AGS monitor. The AGS operator uses a hands-free head set for voice communication with the truck driver and a foot pedal to activate the unit's transmission.

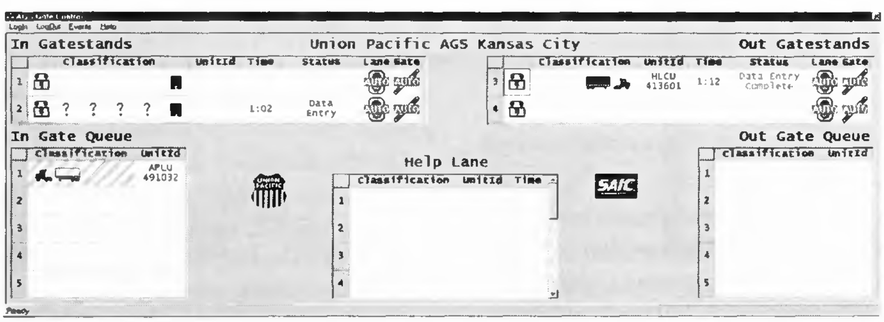
Instructional signs direct the driver to wait until the portal control light turns green. A portal is composed of ten digital cameras, four light curtains, and two Automatic Equipment Identification antennas. There are seven line-scan cameras that take a ⅛" slice of video as the truck drives through the portal at 10 MPH and three area scan cameras that take area pictures of the rear of the intermodal unit and its tires.

The Video Inspection System integrates image analysis, vehicle axle count and optical character recognition technologies. Optical character recognition identifies and scans alphanumeric characters on the left side, right side and back side of a unit to produce a high-resolution digital image of the top, sides, nose, rear, tires and under carriage of all units passing through the portal. These images are stored locally for playback review to inspect damages, validate equipment identification marks and hazardous material placards. The results of this scan are then compared with data residing in the Intelligent Character Recognition (ICR) system, an integrated database of all equipment identification prefixes. The AGS operator can perform a visual inspection of the images after a single unit or multiple units (as in the case of "pups") pass through the camera portal. Using "point and click" screen icons, the operator can review the images.

Based on the images, the vehicle at the yard is then classified into one of the following:

1. A tractor (bobtail)
2. Tractor with chassis
3. Tractor with trailer or container tractor with multiple trailers or containers or non-intermodal vehicles.

FIGURE 2
GATE CONTROL SCREEN THAT UPDATES THE STATUS OF INCOMING AND OUTGOING UNITS

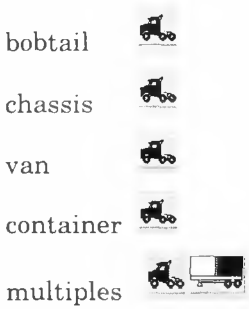


Interior Inspection

The next step is to ensure the accurate inspection of the unit. Mounted directly to the rear of each gate stand lane is a color camera that views and takes live images of the inside of the unit. These images are then displayed and controlled by the AGS operator using the GATE CONTROL function to inspect empty returned units or blocking and bracing of loads to ensure that the load inside the container does not shift in transit. Refer to Figure 2.

Once the unit passes properly through the camera portal, the system creates an icon to represent the unit on the AGS operator's monitor. The icon includes the initial of the unit and its identification number, which are then displayed in the "portal queue" areas on AGS. Refer to Figure 3.

FIGURE 3
ICONS AS THEY APPEAR
ON THE GATE CONTROL SCREEN



Once the icon appears on the AGS screen, the operator begins the inspection process by viewing the images. A *gate stand* refers to an interactive monitor, a keyboard, two-way hands-free voice intercom, call button, driver image capture, printer, electronic driver identification, and a magnetic card reader. A Gate Stand computer is installed at each inbound and outbound lane. The Gate Stand is the driver's interface and lane controller. These computers are intended to gather pertinent information from the driver and transfer that information to the System Controller for validation and further use in the process. The Gate Stand computer is also used to allow the controller at the Playback to communicate with the driver.

AGS prompts the user with screen menus for data entry in order to process the gate transaction. The driver interface is designed to be as user friendly as possible with minimum interaction from the driver yet still gather as much of the required data as possible before the AGS operator is needed (if needed) to complete the transaction. The data the driver is asked to input is relevant to the particular transaction type as identified by the system. In most cases, it is expected that the data input received from the driver will leave the AGS operator with handling only exceptions or lack of required data. If, at any time during the process, the driver is unable to complete the data entry, the AGS operator may intervene and complete any portion or all of the transaction.

AGS allows for inspection at any time, i.e., as soon as the units arrive or at a later time, as long as the images are available. This allows terminal managers at different yards to establish their own policies and guidelines as to when the inspection should be done. While viewing the images the AGS operator may inspect and report damage (if applicable) and verify equipment identification marks. The destination information is supplied and formatted on the playback display. As indicated earlier, since each gate stand has a video camera to capture a live image of the driver, a still snapshot of the driver is captured automatically and stored with the gate transaction. Each gate stand also has a magnetic card reader that allows drivers to swipe their identification cards and capture and match the driver's identification in the system.

System Output

Each gate stand also has an enclosed ticket printer that automatically feeds the gate receipt when the transaction has been processed. A gate receipt is similar to an invoice that vendors use to receive payment for delivering or picking up units. The gate receipt on a complete transaction includes information about the date, time, location, driver name, initial and number of the chassis, yard disposition instructions, and information about damages, if any.

The driver enters the unit initial and number or presses the NO key to identify a bobtail transaction (a transaction to indicate that the driver is in the yard to just pick up a unit. This information is compared with units in the ingate queue to identify a match. If one is found, the unit icon on the GATE CONTROL display on the AGS workstation is automatically moved to the gate stand to associate the data input with the portal images. If a match is not found, the driver is prompted to verify the input and re-enter the data. If the driver validates the information and a match is still not found, AGS notifies the AGS operator to complete the transaction.

Next, AGS checks for equipment classification (in the case of a chassis, gate control is handed over to the AGS operator to complete the transaction as there is no further input required from the driver.). AGS then generates a data packet to send to the mainframe (TCS) to check for billing information. If billing information is not found in the TCS, the system will prompt the driver to identify if the unit is loaded or empty. The goal is to collect as much required data as possible from the driver to assist in any billing inquiry activity.

The next AGS screen captures the seal numbers and contents associated with each unit. The shipping company applies a seal to each unit in order to prevent any tampering with the contents. If the seal is missing, then Union Pacific will not allow the unit to enter the rail yard, until another seal has been supplied and the new number entered in the system. In the case of multiple units (as in the case of "pups"), the driver enters the details for each unit and the steps are repeated until details about all units are entered in the system.

Once the driver completes the input process, the AGS operator assumes responsibility for completing the transaction. The data collected is sent to TCS in the form of a van arrival for TCS processing. If the message is processed without errors, a buckslip is printed at the gate stand and the driver has the option to inquire about units in the yard for pickup. Otherwise the system is reset for the next transaction.

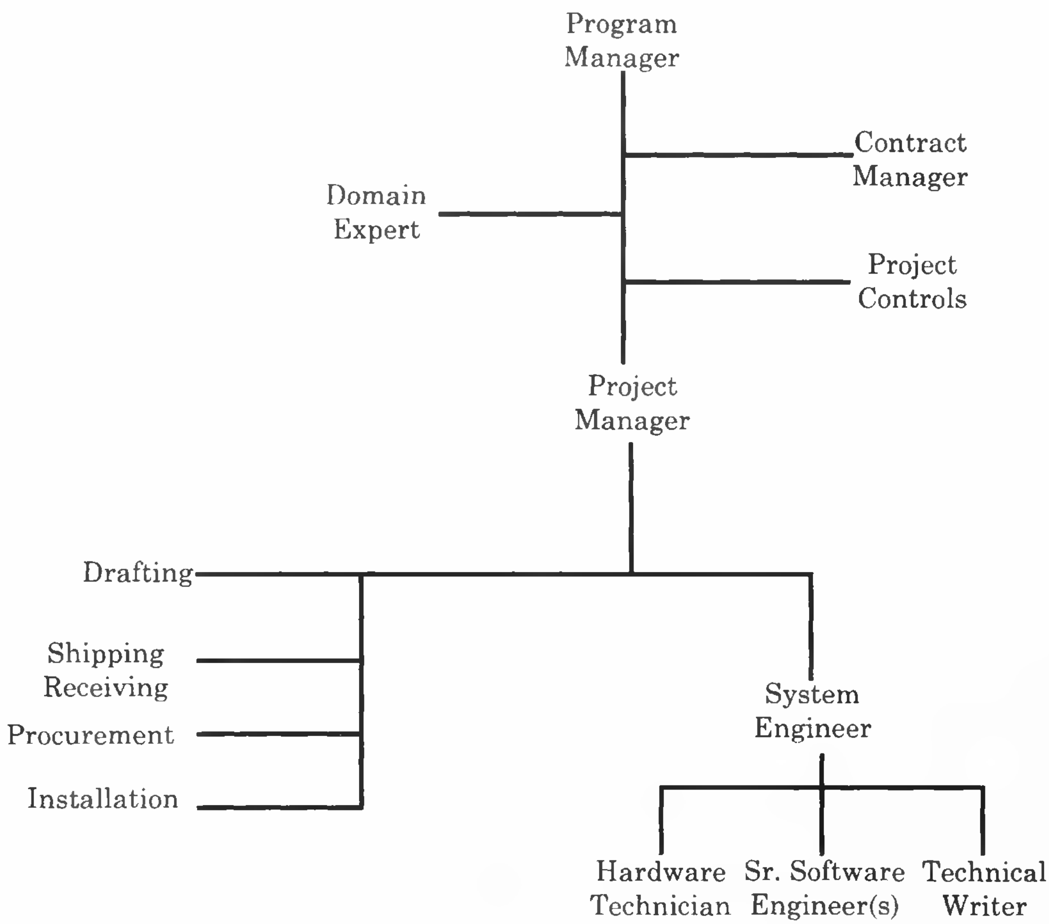
TECHNOLOGY BEHIND AGS

The AGS system consists of Acquisition computers, Gate Stand computers, Playback computers, Image Server computers and a System Controller Computer. Acquisition Computers reside in the Signal Cabin which is physically centered between the In and Out portals. There are three Acquisition computers for each portal: Left Acquisition, Right Acquisition and Auxiliary Acquisition. The Left Acquisition computer is responsible for capturing and transferring image data from the three line scan cameras mounted on the left side of the portal. The Right Acquisition computer is responsible for capturing and transferring image data from the three line scan cameras mounted on the right side of the portal. The Auxiliary Acquisition computer is responsible for the Top Scan, Rear Shot and Left and Right Tire Shots. The Auxiliary Acquisition computers handle the I/O from the portals as well as from the queuing lanes.

Gate Stand computers were described earlier. Playback Computers serve as the user interface to the AGS System and are located in the Operations area of the Gate House. They are used to display truck images and handle the gate process which involves getting information from the driver and verifying that the driver can enter the yard. This process can also involve creating damage reports, registering drivers and possibly establishing a video conference with the driver at a gate stand.

The In-Portal Image Server and Out-Portal Image Server computers are located in a rack in the communications room in the Gate House. Each Image Server handles the reception of the raw image data, creates the viewed images and handles the archiving of the image to optical disk. The System Controller computer is also located in a rack in the communications room in the Gate House and is responsible for handling all of the data packets passed between machines as well as maintaining the truck image database. The team structure for AGS is shown in Figure 4.

FIGURE 4
TEAM STRUCTURE FOR AGS



MEASURE OF SUCCESS

AGS has become one of the most successful information systems in the company's history and continues to yield significant extrinsic and intrinsic benefits to the company and to its customers. A recent cost/benefit analysis comparing hand held technology with AGS shows a 75% reduction in labor at the three existing locations. The ROI of AGS is approximately 40%. Some of the benefits of AGS include

- **Increased Customer Satisfaction**. AGS helped reduce time to process units at the gate by more than 70%. Thus customers were able to get in and get out of the yards quickly, leading to significant efficiencies for both UP and its customers. Further, customer satisfaction increased when AGS was implemented.

- **Increased Revenue**. While revenue attributable to AGS is confidential, it is safe to say that profits attributed to AGS are significant. Further, evidence points to greater throughput for drayage companies, which increases their ability to achieve higher volumes of traffic through the rail yards.

- **Reduction in Personnel**. Significant reductions were achieved in the number of personnel required at the gates. In several yards around the country, the number of internal gate operators decreased by more than 50% while the number of outside gate operators has been completely eliminated.

- **Improved Decision-Making**. AGS continues to play an important role in enhancing the quality of decisions. There has been a significant increase in the integrity and accuracy of critical transportation data collected at the yards, leading to better decision making at the rail yards and throughout the company.

- **Reduction in damage claims**. Finally, AGS has helped Union Pacific to achieve significant reduction in damage claims paid to its customers. Since photographic documentation of all units passing through the AGS data acquisition portals is available, it is easy to settle claims, thus decreasing the number of litigious claims.

- **Leader in the field**. Union Pacific is a leader in the field and hence customers have high expectations of the company. Managers attribute the smooth flow of traffic through the rail yards to AGS. Charles Whited, Senior Manager of the Union Pacific Intermodal Terminal, Marion, AR, says, "For example, on 8/11/99 we did 1,065 arrivals and departures. It is my opinion that traffic flow and congestion is much better than with any other system we have had. Also, this is done with fewer people working the gate. With AGS we have 3 people at peak 7am to 1900pm and one person at other times. Without AGS I believe we would need 8 people at peak and 4 at other times."

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