A Computer for Your Old Hump Yard?

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In 1977 Southern Railway decided to replace an old and hard-to-maintain hump control computer with a new control computer system. The new system was developed entirely by Southern Railway employees. Functions of the new system exceeded those of the old, allowing Southern to eliminate two 24-hr positions. System installation was done in phases at Brosnan Yard, Macon, Georgia; the final phase was completed in September 1980.

In late 1976 Southern Railway was faced with the necessity of replacing an old computer system used for master-retarder control at Brosnan Yard, Macon, Georgia. This computer system had been installed in 1966 as a complete retarder-control system but had been only marginally successful because of multiple tuning difficulties.

The system design required a hump conductor at the hump crest; a scale clerk to produce weigh tickets on the 5 percent of traffic that needed weighing; and a car retarder operator for overriding computer control, making trim moves with the hump engines, and blocking tracks.

Brosnan Yard was handling as many as 3,000 cars per day over its single hump. Management had information that damage claims were high on traffic passing through this yard. The decision to replace the old computer system with newer equipment programmed by Southern Railway employees was reached in the late spring of 1977.

PREPROJECT HISTORY

In 1965-1966 Southern Railway built a new hump yard at Macon, Georgia, on the site of an old flat yard and a swamp. Into this yard went one of the first modern minicomputers, a Digital Equipment PDP-8. The PDP-8 and its input-output hardware were used for controlling both master and group retarders; both system design and implementation were provided by General Railway Signal Company (GRS).

Although the system controlled all required equipment, coupling speeds remained erratic throughout the life of the PDP-8 system except during concentrated tuning efforts. Furthermore, group retarder control in full manual by the car retarder operators was the rule, not the exception, from 1973 on.

Meanwhile, in 1973 Southern had built another hump yard at Sheffield, Alabama, also using a GRS control system, Data General computers, and an information link to the first prototype of Southern's Terminal Information Processing System (TIPS). No scale clerk or car retarder operator was required at Sheffield. The yard was considered the most modern in North America at the time and was an unqualified success.

Therefore, when Digital Equipment informed Southern in 1976 that they could no longer maintain the Brosnan PDP-8 after mid-1978, Southern management was inclined toward replacing the PDP-8 with Data General computers and linking these computers to the TIPS already installed at Brosnan Yard. In addition management decided that in-house development would be desirable; that work was assigned to the Management Information Services (MIS) Department.

COMMITTEE APPROACH

The control of the computer replacement project proceeded through a number of committees. At the top of this structure was the Committee on Computer Usage (CCU). The CCU was a permanent part of Southern Railway structure that determined all major applications of computer technology for the railroad. The CCU was made up of all company vice presidents and those above them. Below the CCU was a group from middle management called Management Information Services--Rail Operations (MIS-OP). The job of MIS-OP was to coordinate efforts of MIS and operations on joint activities. Because MIS would be developing the system for Brosnan Yard, the project was subject to MIS-OP review.

Initially a programming group was assigned to evaluate the project's needs in terms of hardware, software, and development time. The results of this evaluation were a hardware-software plan, a performance specification, and a phased implementation schedule.

Because the system would have to be placed in service in the yard while the yard handled normal traffic, a temporary committee of middle and lower-level management was established to oversee the system installation. This technical monitoring committee was composed of members from Transportation; Communications and Signals (C&S); MIS; Maintenance of Way; and Freight Claims Services. This group was responsible for resolving interdepartmental conflicts and for deciding on solutions to various problems that appeared in the original plan. It was from this committee that the implementing team took its direction.

IMPLEMENTING TEAM

Working under the technical monitoring committee was the actual implementing team. The only full-time employees assigned to this work were from MIS: three programmers and one programming manager. Part-time members were one C&S operations specialist, two C&S supervisors, one superintendent of terminals, and one track supervisor.

Because the programming manager was the senior full-time person on the project, he became the de facto project leader. But because the technical committee was in place, only relatively minor tactical decisions were made without committee direction.

The amount of time spent on the project by the programming team was December 1977 through September 1980. A major interruption occurred between March 1979 and October 1979 as the team was shifted to Linwood, North Carolina, to assist GRS in installing another new hump yard at that location. Of the original group of four, only two remained on the project for the full duration. Of the other two jobs, one turned over twice during the project.

A total of nine programmer years was spent through the final phase of installation in September 1980. The total becomes 12 years if the programming manager's time is included.

An interesting aside on the programming team: No more than two who had technical educations were ever assigned at one time. No one assigned had an engineering degree.

PHASES OF THE PROJECT

The project as a single task was clearly beyond the ability of a relatively inexperienced programming team. This was particularly so because of a July 1, 1978, cutoff of maintenance on the PDP-8. Considering this situation, the only reasonable alternative was to phase in the replacement computer.

Four major project phases were defined. In the first, the control of the PDP-8 was paralleled on the master retarder only. In the second, the master retarder was controlled and the car retarder operators were provided with a cathode-ray tube (CRT) display of information needed to manually retard cars in the groups. At the end of this second phase, independence of the PDP-8 had been accomplished. Third, actual control of the group retarders was taken over. Fourth and most important, lists from TIPS including tracking of cars to destination and automatic weighing of weigh cars were processed. With completion of the fourth phase the positions of scale clerk and car retarder operator were eliminated.

The first three phases constituted the job that had been originally defined for the PDP-8. An important requirement in the third phase was to minimize the amount of tuning done by local yard personnel. This was accomplished by using a high-level programming language (FORTRAN) and by introducing the concept of multiple yard factors sensitive to weather changes rather than a completely different set of values by temperature class.

The fourth phase presented major opportunities because the original equipment design did not anticipate any list capability. Furthermore, only a limited budget was available to upgrade field hardware for this purpose. Cost-effectiveness dictated the budget limitations.

Phase 1 was completed in April 1978. Phase 2 was completed in July 1978, 18 days after the maintenance contract on PDP-8 had expired. Phase 3 was completed in January 1979 just before the need to devote full time to the new Linwood, North Carolina, yard project. Finally, on the day after Labor Day 1980 the fourth phase was completed.

A major project-extending factor between phases 3 and 4 was the decision to replace the first Data General computers (Nova 840s that had been recycled from an early TIPS development) for development of phase 4. The Nova computers were replaced by the then-latest Data General computers (Eclipse S/130s), which incidentally provided additional mutual onsite parts backup with TIPS.

Through all phases of the project much time was spent in the hurry-up-and-wait mode. Especially in phases 3 and 4, test set-up time and test type (tests that used revenue traffic) caused potential conflicts with yard operation. Careful coordination with the local Transportation Department was required to do adequate testing without affecting yard service. Essentially this meant that test time was minimal, project development was slowed, and expenses of the implementing team were high.

MAJOR ACCOMPLISHMENTS OF THE SYSTEM

The three major accomplishments of the system were as follows:

1. Introducing a new computer to an old yard, including an old computer's inputs and outputs, retarders, grades, and basic yard layout. By not having to lay in cable and new field hardware devices (like wheel detectors) major costs were avoided. Adapting some of the old interfacing gear minimized the new engineering effort required, thus saving money and simplifying parts of the system.
2. Providing a new system that was easier to maintain and one that more consistently achieved the coupling-speed goals established by management.
3. Developing system features that allow one employee to do the work of the three previously required. Even though the hump conductor now sits in the seat formerly occupied by the car retarder operator, where his field of vision must exceed 180 degrees, closed-circuit TV and well-conceived inputs and displays give him good system monitoring capabilities for a minimum dollar expenditure. This human engineering performance was particularly important to system success.

HOW SUCCESS IS MEASURED IN HUMP YARDS

A basic criterion used to measure success or failure in a hump yard is coupling speed. Norfolk Southern has a simple method of measuring whether a yard is doing an adequate job on couplings. Coupling speeds are measured by hand-held radar according to a sampling scheme developed by Freight Claims Services. Of observed couplings to cars that have stopped, 94 percent or more must be at or below a nominal 6-mph coupling rate.

Stalls are not counted as an explicit part of the coupling speeds, although notes on stalls are kept. A track kickoff rate of six tracks per shift is acceptable, regardless of cause.

Coupling speed tests are performed on at least a quarterly basis. They serve both as a scorecard on performance and as a tuning tool. Results are widely published so that everyone is getting the same information without undue interpretation. Other criteria of importance are hump throughput, classification accuracy, and correct handling of TIPS interface.

RESPONSIBILITY

During the development of the system phases all the departments were expected to cooperate to see that they supported each other's activities. This mechanism was enforced via the technical committee when conflicts or other problems arose. The departments' activities were in addition to any of the normal responsibilities they variously had toward normal yard operation during system testing and implementation.

Now that phase 4 has been completed, day-to-day responsibility for system operation falls principally on two departments. Transportation is responsible for enforcing discipline on the hump conductors as in any other non-system-related activity that the hump conductors perform.

C&S is responsible for maintaining computer inputs and outputs as well as all field hardware associated with the system. Any tuning changes in the yard description data are also the responsibility of C&S.

On other than a day-to-day basis, MIS provides for computer hardware maintenance by Data General and software upgrades as necessary. MIS also assists C&S with tuning on request and system troubleshooting on an on-call basis. No MIS personnel are permanently assigned to Brosnan or any other yard.

PROS, CONS, AND COSTS OF DEVELOPMENT STRATEGY

There was an overall plan and phase sequence from the project's outset, although many specific details were not settled until well into the project cycle. This approach caused the goals to remain clear even as the problems were muddled through.

Pros

Recycled computers were used to extend the useful life of these systems until prices for the newer equipment fell and software on the newer computers was improved. The phased approach to system function upgrades combined easily with the computer hardware recycling.

The phased approach minimized the negative impact of change on yard operation. Each phase evolved from the previous one, which almost led the user ahead. Major retraining of personnel was not required.

Most of the code was developed on site and was tested as developed. Some of the code, particularly that for handling exceptions, was better tested in the field than in any laboratory that could have been economically created.

The implementing team gained by direct exposure to the experts, the car retarder operators. Much of their experience was eventually translated into program refinements.

Cons

The large amount of out-of-town work contributed directly to the high personnel turnover experienced during the project. Developing the experience of the implementing team took more time than hiring a new team of experts. Out-of-pocket expenses were relatively high simply because of the implementing team's expense accounts.

An individual railroad cannot afford the overhead of a large development staff such as the signal companies possess. This tends to concentrate too much specialized information in too few hands.

Old field hardware and cables caused the use of inputs that were less than ideally located and more error prone. Eventually several had to be replaced and relocated. Some had to be enhanced by backup devices.

The lack of a central development and test facility forced some work into the field that could have been done without incurring travel.

Costs

A definite trade-off exists between the expense of keeping a team in the field and the capital costs of a central laboratory.

Control systems involve a specialized type of programming. Railroad control systems are even more specialized. Hiring or training personnel with such specialized skills is costly.

For an automatic system to work well a high degree of maintenance of facilities and equipment is required. This includes such mundane items as working rail greasers and well-maintained track grades, all of which is costly.

PRACTICAL SYSTEM LIMITS

The master and group retarder configuration is becoming ever more inconsistent now that longer cars and constant-contact side bearings make up a large percentage of the car fleet. At older yards that have tight curves in the bowl tracks this problem is becoming severe. Some measure of curve resistance is needed to reduce the inconsistency. The obvious alternative to this is tangent-point retarders.

Human factors must be carefully considered. An ill-defined approach to how the hump conductor is to relate to the system can make the job appear impossible.

Simple-looking but hard-to-achieve changes to yard layout can improve performance. For instance, having some accelerating grade through the group retarders can add to the system's recovery capability for cars that are controlled to below their target speed.

SUMMARY

Puting a computer in an old yard is not a panacea. A successful project to do this requires a strong commitment from management to that goal, particularly if jobs are to be cut off as a result of computer installation.

A computer by itself will probably help in freight claims by lessening damage, but this may slow the humping rate. A slower hump rate may not affect the number of cars per day over the hump, but less hump-engine time is available for duties other than hump activities.

Maintenance costs are higher than in a manual yard because of a larger array of equipment to be maintained. If the yard is adequately configured, a computerized master and group retarder scheme will reduce damage, labor costs, and misroutes. Without a good yard layout, installing a computer will probably be no help in reducing damage claims.

The VR-IV Retarder Control System

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A system for controlling the speed of freight cars coming out of car retarders in classification yards is described. The key element of the VR-IV system is the use of an acceleration servo to cause cars to decelerate at a constant rate and achieve the proper exit speed just as they leave the retarder. This is in contrast to the velocity servo used in earlier systems. With a microprocessor, the VR-IV system continuously repeats the computation of deceleration that will produce the desired exit speed; then it operates the compressed-air application or exhaust valves to produce the proper air pressure in the retarder cylinders.

In this paper a car retarder speed-control system is described that was designed to cause cars to decelerate uniformly throughout the entire length of the retarder. This is a desirable feature for several reasons. First it distributes the wear evenly throughout the retarder instead of causing the work and the wear to occur at the front end. Second it allows cars to maintain a higher average speed through the retarder, which increases the production rate or throughput. And third, in the case of electropneumatic retarders, it produces a substantial savings in compressed air by maintaining a relatively constant air pressure for any given weight of car.

OVERALL YARD CONCEPT

Before the Union Switch and Signal Company (US&S)