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ELECTRONICS AND THE RECOVERY OF LOST RAIL TRAFFIC

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The recent merger of the three major northeastern railroads into two advances to the forefront ideas for conserving railway plant and railway technology which until recently would have been considered untimely. This paper, based entirely on technology already known and approved, if not always on railways, outlines one concept that seems worthy of consideration. The text must be evaluated as a framework, within which details remain to be investigated. We present it because its potential benefits seem to exceed its potential costs.

Why have trucks become America's dominant freight transportation mode over the past thirty years? According to the President of one Trucking Association, the reason is "the more flexible...and timely service that motor carriers provide". Such remarks could have been uttered by many others in similar positions.

It would perhaps have been more precise to claim that trucks have become the dominant medium-haul high-value quick-despatch freight transportation mode. Despite higher fuel and labor costs per ton-mile, trucks have wrested this presumably profitable source of revenue away from the rail mode, especially as private sidings have become fewer and fewer.

It has not yet been calculated, let alone decided beyond argument, exactly how much trucks do or should pay for their share of joint-use roads. They are sometimes deemed not to be paying fully for their infrastructure, contrary to railroads. Nevertheless, while this cannot be debated here, the development of superhighways, expressways and the Interstate system has guaranteed ever more efficient and so more severe truck competition.

*A modified version of this paper was presented at the 1994 Conference of the Canadian Transportation Research Forum

Railroads have responded by way of their already-owned or newly-acquired trucking associates and subsidiaries, sometimes operated at arm's length, but more importantly, by their introduction of intermodal technology, most often TOFC (piggyback). This originally had three versions: one offered to their trucking competitors as Plan 1 (truck-billed) piggyback, one used by themselves as Plan 2 (rail-billed) replacing boxcars, and Plan 3 where the shipper provided the trailer, often used by forwarders.

Plan 1 has not until recently been adopted with enthusiasm by truckers, but several railways have now made important high-volume arrangements with J B Hunt, America's largest trucker. The operation of small-crew fast and short piggyback trains, known by some as "Sprint", is said to be a success, but they move only at long intervals between two selected points, and don't duplicate the frequency and flexibility demanded by trucking's clients, especially those at intermediate points. A T Kearney conceived the unique "Mini-Piggi" some years ago, with ability to load and unload anywhere, but it is not in operation. The CSX/CP Iron Highway purports to do this as well. But the industry has yet to find a way to recapture all the great mass of traffic back to the rails. Can a new strategy be devised to restore those lost revenues, since the competition can't simply be eliminated? That question is addressed here.

The Concept

The ability to control a locomotive from a distance has been demonstrated, but never exploited properly.[1] In 1958, at the urging of the Iron Ore Company of Canada, General Motors, working with General Railway Signal and Canadian National, built an experimental locomotive that pulled a train 120 miles with no hand at the throttle. This was followed by a radio-controlled electric locomotive for that company (Fig 1) Its radio range is short, as are all applications of that form of control. Long distance transmission of control must be developed for a new rail strategy.[2]

1 Robert L Banks, unpublished paper, ICHCA/CIT joint meeting, Ottawa, 28 June 1993

2 Operational Functions of ATC, W J Moore Ede, presentation to US Federal Government Agencies, 29 January 1987

The subject of this paper is the feasibility of automatically-operated small trains with no crews at all, in large numbers at short intervals, designed to penetrate truck-dominant territory. The saving over crewed operation in cents per ton-mile would be significant, but more importantly the frequency of service would duplicate that of the trucks swarming over the highways, often within sight of the railroads themselves. To attract current truck traffic onto these very railways is at the heart of this proposal, not directed therefore at making rails as they are today competitive with trucks, but rather at seducing those trucks onto the rails at a price below their avoidable costs (consisting 20% of fuel and over 35¢ a mile for labor). In other words, redesigned Plans 1 and 3, while self interest would attract rail-owned Plan 2.

We suggest that only speed and frequency to match the trucks', combined with rail costs to attract them, can accomplish the seduction. High speed is of course itself the way to optimize equipment turnover.

Picture 300-400 miles of railway, with capacity much in excess of present traffic levels - an underutilized investment. And picture a modest terminal at every point within that territory that produces or terminates respectable truck traffic. Picture the conventional trains being transferred to another somewhat parallel line, if there is one, or being integrated into this truck-competitive system. Picture a central authority in charge of all this.

Each terminal facility will be paved, with simple circus-loading ramps. It will store a few cars ready for loading, incoming cars being made empty, and some motive power to pull them, as well as to hostle them as needed. Sometimes deadheading power, crewless of course, may have to be summoned, on notice to headquarters.

Tractors and trailers, both common carrier and private, including rail-owned intermodal vehicles, will be admitted through a gate into the loading area. Containers are not yet favored by any but the very largest carriers and they will be handled complete with chassis. To separate them would be of no additional benefit, and would involve special equipment and more time. Road Railers too will be welcome, with a supply of their own rail wheels stored nearby.

No more than two will suffice for a terminal ground crew, one working with the truck driver to secure his trailer, the other handling ticketing and customer contact.

With the large fleets of the major carriers, the team of driver and tractor may stay behind at the terminal, perhaps awaiting the arrival of an incoming trailer. The team can, of course, come in and go out light at no charge. In some cases, another team would drive away the arriving trailer; arrangements would vary with the various carriers' convenience and strategy.

A standard TOFC 89' will accomodate two 40' trailers; an articulated pair of 89' cars with aprons up to three of any length. But as will occur often, what do we do with the driver and his tractor-trailer, especiallly if he owns the rig? There is room on a 89' car for the longest rig on the road to be carried complete, probably at an extra fare. But he cannot stay with it himself, as the carriage of persons is burdened with such regulatory impedimenta as to be out of the question. So several drivers will be taken by van to their pick-up points, to coincide with their rigs' arrival by rail. This could turn out to be a multi-stop jitney service up and down the route, all included in the base rig price. Occasionally fatigue, defective equipment or the prospect of rain will attract the casual driver off the road.

Loaded cars must be dispatched promptly so as to provide the immediacy characteristic of truck freight. Perhaps three or four cars would be ready to leave together, but there must be no waiting for tonnage. Since no crews need be called, there can be no restrictions on departure times, no schedules, no extra trains, no conventional railroading. The rails won't change, but now they belong to the trucks.

So at some particular traffic volume there might be several of these mini-trains and their low-power locomotives at various points on the line. When single track remains the standard, there might have to be additional passing sidings, and at some time in the future doubling the track will not only provide capacity but may prove more economical. Higher speeds may demand that slow-order curves be modified.

Minor snowfalls will be cleared by simply running trains through them. More snow will be cleared by flangers or plows in front of unmanned locomotives, but major snow falls will likely block highway and railway both.

At some point in the process, the attendant himself might have to start the engine, but usually it would remain at idle. He will hostle the locomotive over onto the little group of cars and test the brakes preparatory to setting the controls and having it enter the main line.

At the outset, existing lower-powered diesel-electric locomotives, probably older, will suffice after gearing to truck speed and fitting with new controls. They need never to be turned, they are bi-directional anyway. In due course they will become obsolete and will need replacing by units with a tractive effort to lift, say 400-500 tons, and horsepower to move that tonnage at truck speed. There may be no locomotive of that specification available at first, but the prospect of profit will eventually inspire some innovation. Meanwhile, two big Detroit Diesel truck engines and Allison transmissions can be happily married, as exemplified by the Budd RDC railcar and the General Motors GMDH-1 locomotive.

How is a locomotive to run without a crew? Automatic operation requires an apparatus to respond to control information, a system to provide the information needed to route the train and to supply that to the locomotive.[3]

A train must be able to be started, accelerated, run at speed, braked and stopped. Throttle setting and generator excitation can be regulated to accelerate smoothly, limiting tractive effort to avoid or immediately arrest wheel-slip. Such automatic acceleration is now used in electric multiple-unit commuter trains, and its adaptation to locomotives will not be difficult.

Many locomotives now have speed-limiting governors, usually sounding a warning and then applying the brakes if it is ignored. Where there is a system of speed control, as in the Northeast Corridor, there are governor settings for various events, such as through crossovers and approaching stop signals. In this proposal, instead of warning - there is nobody to warn - the governor will be set to cut off power and apply brakes, then releasing them when the speed has been reduced. While speed control of long freight trains demands delicate handling, very short trains will present no difficulty. When stop is called for, power is reduced to idle and the brakes applied.

3 The Case for Remote-Control Locomotive Technology, Martin A Schlenker, Proceedings of TRF, 1993

The skeptic may ask "how is control information going to move the throttle and brake handles, and vary generator excitation?" Electrically-controlled contactors and magnet valves do that now, as with slave units in long freight trains, and so, to a degree, in any multi-unit locomotive consist.

One reliable way of transmitting control information to a locomotive is by using coded cab signals, as on the North-east Corridor, the Union Pacific and elsewhere. As part of the automatic block system or Centralized Traffic Control (CTC), coded, ie pulsed, AC is sent through the rails (from a signal location or where one could be) along one, through the front wheels and axle and back along the other. The pulse rate per minute indicates the speed limit imposed by the signal, eg 75 for 30 mph, 120 for 40 mph, 180 for maximum speed, etc, while none at all means "prepare to stop short of obstruction", 15 mph at most. The AC induces a corresponding alternating voltage in coils just ahead of the wheels, which is amplified, and via tuned circuits, selects the proper speed governor. This can be modified to respond to 170 pulses per minute for a new speed.[4] As part of CTC, the coded signal is fail-safe and a loss of power or broken wire will result in the most protective order. It likewise provides broken rail protection.

But for the automatic train operation discussed here, the absence of code must stop the train, not merely slow it to 15 mph. Because short trains can accelerate so quickly, the three or four speeds of a conventional cab signal system will likely be enough.

This system spaces trains so the distance from the first warning to the obstruction is no less than the stopping distance for the most poorly-braked train (the fastest or longest). Very short trains, as envisioned here, will have very short stopping distances, so it follows that the system can be changed to space them closer as traffic volume increases.

4 High Capacity Signalling for the Northeast Corridor Harvey M Glickenstein PE, Thomas A Dyer Inc, and Gregory A Kelly PE, New Jersey Transit, Proceedings IEEE/ASME 8 February 1994

CTC combines a block system with central, or remote, control of switches and their protective signals, subject to safety control; a switch can be changed only with a stop signal and a clear track. A control signal can be set at stop by an operator, but can show proceed only if the switches are lined and the automatic block circuits permit it, just as for a block signal. Such controls from a central point are sent over copper wire, microwave or fibre optic. That communication system informs the central point as to the position of switches and signals, as well as the position of trains.

CTC is of course in wide use, but is not as common on double track as on single. As foreseen above, traffic may someday require doubling, but the expensive part of CTC is operation of siding switches and two-way signalling. not needed with double track, except for provision of turnouts to terminals, hence the economy mentioned.

Computer-assisted dispatching, a way of operating large areas of CTC partially automatically - although under human supervision - is in use on several railroads. To accomodate a great many trains, enhanced memory and programming will be required. Once a train is introduced into the system, with its destination specified, a central computer will line up its route and keep track of its location from section to section. Locomotives can be tagged with radio-responsive identifiers, and devices to read them are set up at suitable places, linked to the central computer. The groundsman will attach this tag as his train is about to leave.

Advanced Train Control System, known as ACTS, has been developed by the Association of American Railroads and has been introduced into Canada following a serious collision. ACTS does not, however, provide absolute control of train operation, in that it does not yet start, run or stop a train. Its function is communication with the crew but not control, and it provides that in many forms.

The Burlington Northern has been experimenting with the ARIES system. a sophisticated ACTS, in which a central computer instructs the train as to its behavior in various locations. The train "learns" of its location through the Geostar satellite which gives a radio receiver its location from satellites emitting precisely-timed signals. A locomotive with such a receiver transmits back its location to the computer via UHF and a number of beacons along the track. The next step will be the actual ordering of the locomotive to perform. GM Hughes Electronics and GM Electro-Motive Division have been investigating such a system

Various safety devices, such as dragging equipment and hot box detectors can be tied into the block system so as to stop the train. A carman or signalman will have to be sent to the site to attend to the trouble and then reset all the controls so that the train can proceed. The central office would be notified by radio.

Electrification

If and when traffic has built up to a critical mass, management will contemplate electrification, with its superior fuel and maintenance costs, and the possibility of great acceleration through short-time motor ratings. Dynamic braking holds no advantage with short trains. The locomotive will have the same attributes as the diesel, and once again, there seems to be no suitable local candidate. Figs 2 and 3 show old electric locomotives of about 800 HP and 30,000 lbs tractive effort. Their tonnage ratings were about 1,000.

A potential obstacle is the cost of the wire. 600-volt wire has been installed in LRT situations at about $300,000 per mile, including sub-stations for conversion from public-utility AC to DC. 600-volt unfenced overhead is no menace to anybody on the ground, as demonstrated wth ordinary street railways.

Marketing and Pricing

How will this new service be marketed, and paid for? The usual marketing department will approach a completely different group of customers: truck lines, common-carrier and privately-owned, and the mass of owner-operators who will have to be solicited one by one, maybe even at truck stops. Prices will be as high as possible and lower than truck costs, varying by mileage, perhaps by day of the week, maybe discounted for volume or for round trips, enough to generate loyalty. In short, all the pricing strategy common to a new market. To avoid reliance on cumbersome accounting, a system of entrance-exit tickets, as seen on tolled highways, as simple, where the "in" is printed at the top and a menu of "outs" underneath, each one priced, to be collected on the way out or by credit card. A more advanced arrangement is found on certain rapid transit operations, where a "bank" of miles is debited each trip. There may be others, but the driver and the railway each need only a simple audit trail.

Other considerations

There will be public apprehension of the unknown; crewless operation of strange little trains on familiar tracks. This will call for sophisticated public relations, careful contact with political and other thought leaders, and will certainly be followed by government curiosity, then close scrutiny and finally regulation.

For example, grade crossings. Unprotected crossings will be no less safe than they are now, while orotected ones will be track-circuit activated as they are now, possibly with longer arms to prevent endarounds. But automobiles will stall now and then, acts of others' negligence but not to be dismissed as such. A manned locomotive at speed can hardly ever be stopped short of an impact, so an unmanned one presents no greater hazard. Still, it will be wise to fix a crash-sensitive device on the front of the locomotive, such as a length of brittle pipe connected to the train line, to be split on contact and apply the air brakes in emergency. But if there is even the merest contact, it will call for a railway policeman to be sent. As for the standard crossing warning, a radio-frequency sender must be placed at the approach, so a frequency interrogator on the locomotive will respond with the usual code whistle signal. There will be demands for grade crossing elimination, nonetheless. Rotating headlight beams and strobe ditch lights might be mandated, or even a continuous bell.

There must certainly be appreciation of Labor's views. Those mainly affected will fall into three groups. There will be no reduction in track and bridge maintenance, and an increase in signal maintenance. Locomotive and car maintenance will stay in tune with mileage, likely no reduction. Running trades have already been affected by the traffic loss, so that group must be trained and redirected into automatic electronic train operation positions.

In any event, the greatest effort must be made to expose the idea early and to enlist the understanding and support of Labor leadership in the introduction of what will be job preservation and eventually job growth.

The community will observe several side-effects from a truck-dominant railroad line. One is a reduction in fuel taxes, with intercity operators' trucks coming off the road. This effect will be offset by a reduction in highway maintenance costs and congestion, as well as demands for more lanes in critical corridors. The shift from high to low fuel consumption per ton-mile will reduce exhaust gas pollution, not only quantifiable but seen and felt to be beneficial. It does appear that the entire idea is a proposition.

Here is the end of gross ton-miles per train-hour as the index of freight train efficiency. There will be more ton-miles, and in the absence of crews, a train-hour will have no meaning. The index of net ton-miles per operating dollar will be of much greater interest.

Since all revenue will come from truckers and all movements dictated by them, this becomes the Truckers' Railroad, just as so many highway have become truckers' highways.

One reason for governments introducing commuter trains has been to forestall widening highways. Is it too fanciful to speculate that a government might encourage, even actively support this development as a form of "highway improvement"? Not much can be built or even widened for the relatively modest sum needed for an electronic trucker's railway.

While pushing for the Mulberry harbor project to be used on the Normandy beachhead, Winston Churchill wrote at the foot of a secret message about the problems "Don't argue the matter. The difficulties will argue for themselves".

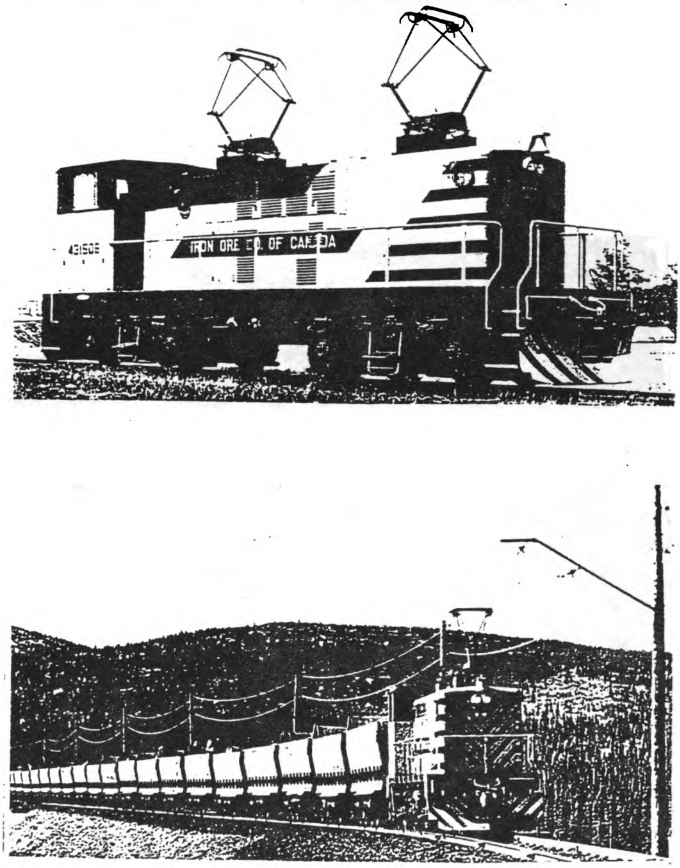

Fig 1

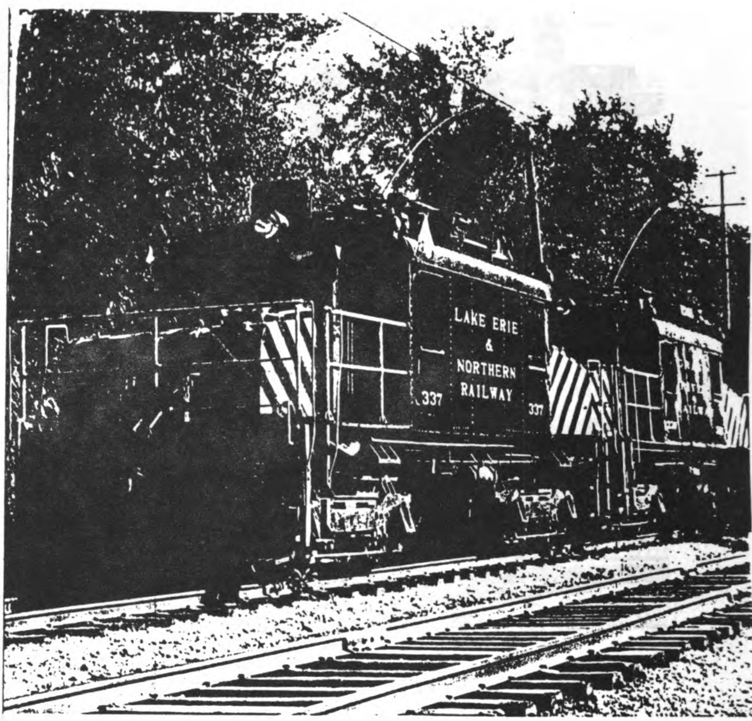

Fig 2

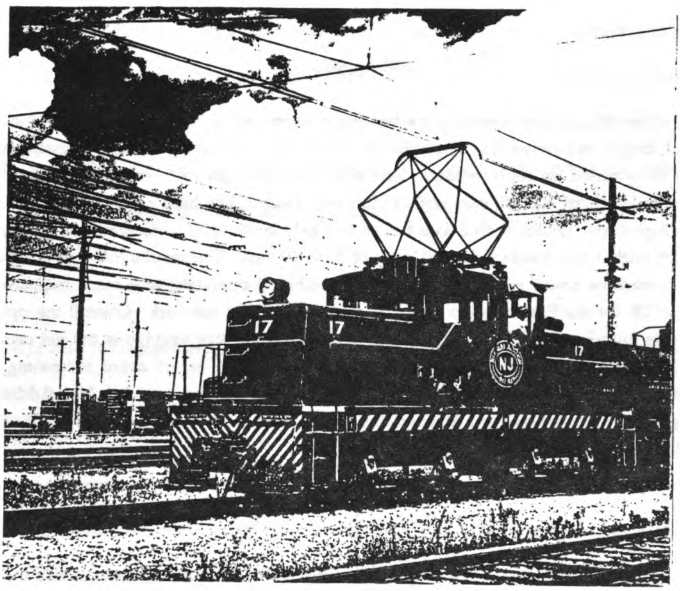

Fig 3