

Autonomous Vehicles in Alberta

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The Province of Alberta is a land of opportunity with blue skies, wide open spaces, natural riches and efficient large scale agriculture. There are also unique challenges, since Alberta is land locked and has extreme weather.

The province is consequently highly dependent on pipe lines, railways and long distance trucking to get export products to market, but baby boomer truck and train drivers are retiring in large numbers, causing a driver shortage and a transport bottle neck.

The railways are running at capacity. Grain is backed up on the prairies and cannot get to market. Since August 2017, Canadian National Railway Co. has canceled almost 13,000 hopper car orders, and there are 1,072 outstanding orders for rail cars as of Feb. 8, data from the Agriculture Transport Coalition show. Another 996 orders for hopper cars from Canadian Pacific Railway Ltd. haven't been filled. Canadian National Railway is calling older drivers out of retirement to move the grain backlog.

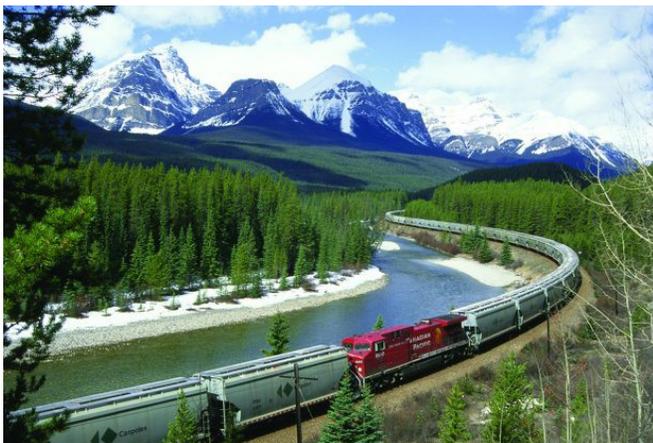


Figure 1 – Very Long CPR Train

Crude-by-rail has picked up and loadings at three large terminals monitored by Genscape Inc. rose to 110,000 barrels a day by the end of 2017. Further

growth is restricted by the shortage of train drivers. Canadian National Railway currently operate trains up to 4200 meters in length. Modifying the railway system to handle even longer trains is necessary, but it will take years to execute and then citizens will complain when having to wait at a level crossing for a 5 to 10 km train to pass, necessitating more overpasses to be built.

The oil pipe lines are full and some expansion plans are blocked by aggressive neighbouring states. A new partial upgrader project, to thin the bituminous Alberta oil, was started. This 2 billion Dollar project is projected to improve pipe line flow rates by 30 percent, but it will take years to build the plant.

According to the transportation consultants CPCS, the majority of goods move by truck and the trucking industry produced more than \$19 billion in GDP in 2014, which is more than the air and rail transportation industries combined.

The long distance trucking industry can respond quickly to changes in demand, but it is also constrained by a dwindling number of aging drivers. According to the 2011 National Household Survey (NHS), there were 283,185 truck drivers employed in Canada and 22% of them were between the ages of 55 and 64, meaning that 6230 drivers retire each year and too few young drivers enter the profession.

In Canada and the USA, long distance trucks are currently limited to one or two trailers with a maximum vehicle length of 19 meters. In

Australia, road trains consisting of trucks with three or more trailers of 36.5 to 53.5 meters in length are used in some states. The trucks have an innovative steering hitch system to keep the trailers stable behind the tractor. This is a proven solution to expand capacity, but it is not popular with drivers of smaller vehicles, since the long connected vehicles cause problems at some intersections.

Autonomous trucks provide the ultimate solution to the long distance driver shortage. This technology is slowly being rolled out. In Arizona and Nevada, long distance autonomous trucks of Uber and Tesla are already doing their first experimental deliveries. At this time, the vehicles are used to move goods between highway truck stops. Local deliveries are done by human drivers. This is likely to remain so for the foreseeable future, since a human being is required for various reasons to transact the deliveries.

It is therefore clear that Canada would need to introduce more than 5000 new road trains and autonomous trucks per year, just to make up for the high retirement rate of boomer drivers.



Figure 2 - 53 meter Road Train, Australia

There are multiple social and engineering challenges to the successful deployment of autonomous vehicles. The transport legislation and regulations need to be amended to allow the use of new and innovative transport solutions, before anyone can start to experiment and deploy autonomous vehicles on public roads. If Alberta would ignore this development, then autonomous vehicles will become ubiquitous elsewhere and unable to operate here, due to incompatible

highway laws.

Autonomous vehicles require a network of sensors, beacons and data links to ensure safe operation in all weather conditions. The control systems must be proven to be as good or better than human operators. Human drivers require training, testing and licencing. Autonomous systems also require licensing and the tests need to be standardized world wide. Therefore, the Alberta Government should establish a test centre for autonomous vehicles where these systems can be certified for use on public roads. Insurance policies also should be adapted to this new reality.



Figure 3 – Truck Friendly Large Roundabout, Dubai

The Alberta road infrastructure needs to be upgraded to accommodate the required increase in long distance transport. As an example, the United Arab Emirates has no general freight railway system. Instead, it has a system of truck roads. On normal highways, trucks are banned or limited to the right hand lane, while on truck roads, small vehicles are banned or limited to the left hand lane.

The long vehicle merging problem is handled by keeping intersections on truck roads few and far between and using truck friendly large diameter roundabouts and fly over bridges with gentle curves, providing ample opportunity to merge and change lanes.

Autonomous vehicles are able to navigate along roads using the same cues that human drivers use: Road markings, road signs, road edge detection, obstacle detection, other vehicle and life forms

detection, using an array of cameras, ultrasonic SONAR and laser scanning LIDAR, with Optical Flow processing. The Global Positioning System satellite navigation helps, but commercial GPS is only accurate to about 6 meters, which is not sufficient to determine where the road lanes are. In low visibility and snowy weather, it is very hard to tell where exactly the road surface is, to human and autonomous drivers alike.

To improve safety of operation in inclement weather, future expansion of the Alberta road network should include upgrades to augment the GPS system with ground based transponders to improve the accuracy, integrity and availability thereof. This will also assist air navigation.

The Alberta data internet system should be improved to ensure reliable, high bandwidth access along all major road ways. This is required for efficient delivery of route plans, map segments and dynamic road condition data to moving vehicles and the return flow of telemetry data to the autonomous vehicle operations centres.

Autonomous systems generate large amounts of sensor data which could be shared with other vehicles in their vicinity, to enhance the overall efficiency and safety of vehicles moving along the road corridor. Sharing of telemetry data, could largely eliminate the occurrence of multi-vehicle accidents by providing timely pre-warning to oncoming vehicles.

A human driver or an autonomous vehicle, can

never rely on any single input to make a decision. If it would, then a bad/maliciously altered road marking could cause a vehicle to stop forever. In an auto driver system, the data from multiple sensors are fed into a statistical analysis engine (a Bayesian or Kalman filter). The probabilities are weighed and fused and the navigation decisions are updated in real-time as the vehicle moves forward, in much the same way that a human driver would subconsciously do, but the additional information available to an auto driver could improve safety of operation beyond the capabilities of a mere mortal.

It is therefore clear that Alberta should grab the opportunity and work towards an efficient modernization of its transport infrastructure and industry, to ensure the future prosperity of the province.

About the author:

Herman is an Army Signals Officer, Electronics Engineer and Computer Scientist. He has been building radio communications, navigation equipment and autonomous helicopters since the 1980s.

Further Reading:

- <https://www.tc.gc.ca/eng/policy/transportation-canada-2016.html>
- <http://cantruck.ca/truck-driver-shortage-accelerating-according-to-new-cta-study/>
- <https://www.bloomberg.com/news/articles/2018-02-15/rail-crunch-leaves-oil-wheat-stranded-out-on-canada-s-prairies>
- <https://www.bloomberg.com/news/articles/2017-12-15/canadian-oil-shippers-find-rail-space-is-scarce-as-prices-slide>