The Dispatcher

Telematics Industry Insights by Michael L. Sena
February 2018 – Volume 5, issue 4

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* HUMANLESS-DRIVE

This is a vehicle piloted by a non-human which is capable of taking itself and passangers anywhere a vehicle driven by a human can be taken at any time. I use this term instead of 'driverless' since driverless connotes the absence of a driver, human or otherwise. The terms 'self-driving' and 'autonomous' can imply varying degrees of mechanical or software assistance to a human driver.

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No Humanless-Drive Without AGI

LET'S PUT ASIDE for a moment the question of whether humanless-driven motorized road transport vehicles (MRTVs)[1] are both necessary and sufficient for reducing deaths, negative environmental effects and traffic congestion, compared to alternative solutions for achieving the same goals. Let's focus on the real question, which is whether ***humanless-driven**** MRTVs that can take you and me wherever and whenever we want to go are even possible. I believe they are, if and when we achieve artificial general intelligence. Artificial general intelligence (AGI) is the intelligence of a (thus far hypothetical) machine that could successfully perform any intellectual task that a human being can perform (including driving a car, bus or truck). This definition, as well as the inspiration for this article, come from Max Tegmark's book, **LIFE 3.0**.

LIFE 3.0 is not on the NY Times' '2017 Top Ten Best Sellers' list, although I feel it should be. (On January 1st, it was #38 on Amazon.) It's a book about artificial intelligence written by a MIT physics professor, and it should be compulsory reading for everyone involved in any way with vehicles that will not be driven by humans (i.e., humanless-driven). Tegmark is a 'Ted Talk' celebrity who makes science understandable, in the tradition of Carl Sagan, and in **LIFE 3.0** he does a superb job of explaining both the technical and philosophical nuances of artificial general intelligence. Tegmark is also the initiative-taker to the ***Future of Life Institute (FLI)***, which is bankrolled by Larry Page and Elon Musk and counts Steven Hawking among its distinguished board members. Its primary mission is to keep artificial intelligence beneficial.

First, let's look at the task of driving. Humans are the only species that drive cars. Car-haters might counter with: "That's because all other species are smarter than humans." We know that's not true, but why is it the case that driving is a human trait? There are well-documented reasons for this.[2] Marc Hauser, director of the cognitive evolution lab at Harvard University in a 2009 article in SCIENTIFIC AMERICAN[3] states "mounting evidence indicates that, in contrast to Darwin's theory of a continuity of mind between humans and other species, a profound gap separates our intellect from the animal kind." These abilities, which Hauser believes are the essence of our "humaniqueness" are: 1) Generative computation – Humans can take a learned rule and create new expressions and mix different learned elements and create a new concept; 2) Promiscuous combination of ideas – mingle different domains of knowledge and generate new laws, technologies, social relationships; 3) Mental symbols – encode our sensory experiences and share them with others; and, 4) Abstract thought – the contemplation of things beyond what we can sense.

Theories of driver behavior are based on the idea that human behavior is determined by how humans process information, that is, cognitive processes. This is why it is difficult to separate

theories concerning how humans obtain and apply complex skills and theories concerning risks and motives. Driving has been described as a hierarchical decision-making system in which motivational aspects (why we do certain things, like drive too fast) and cognitive aspects (how we view certain situations, like overestimating our ability to manoeuvre in a dangerous curve) of driver behavior are combined. Driving is a complex cognitive task that requires the ability to accomplish complex and often conflicting goals. This is very close to the definition of 'intelligence', which ac-cording to Merriam-Webster is 'the ability to learn or understand or to deal with new or trying situations'. Tegmark in LIFE 3.0 defines intelligence simply as "the ability to accomplish complex goals."

It is important to differentiate between driver performance (what the driver can do) and driver behavior (what the driver does do).4 Driver performance relates to the driver's knowledge, skill, perceptual and cognitive abilities. Driver behavior is what the driver chooses to do with these attributes. Some individuals are simply better drivers than others, just like some individuals are better musicians, mathematicians or magicians than others. There are individuals who are 'naturals' or prodigies, who can pick up a violin and start playing Paganini's Caprice No. 24, but most of us require years of practice before we can even hit the right notes. It's the same with driving. Experience is not only the best teacher but the only teacher. Experience isn't programmable, it is learned, and when it comes to driving, it is very much related to the goals of the driver. A race car driver turns out to be a fairly lousy everyday driver because he or she wins the race (the main goal) by taking risks. Risk-taking is a bad trait for a regular driver.

As all The King's Men are learning, making Humpty Dumpty think like a driver is as difficult as getting him back on the wall after he has fallen off, or, as in Alice in Wonderland, helping him to distinguish Alice's face from any other. AI devices, like Google's DeepMind and IBM's Watson, are fabulous at accomplishing one goal at one time. What AGI will do, when we get there, is enable the AGI de-vice to accomplish multiple goals at the same time so it can drive a car. Now we come to the really hard part, which is the basis for Tegmark's book and for the Future of Life Institute: How do we make sure that the AGI de-vices' goals are consistent with our (meaning human) goals?

In 2001: A SPACE ODYSSEY (1968), the following dialog embodies the dialectic between a future super intelligent machine, the Heuristically programmed ALgorithmic computer (HAL 9000), and a human being, Mission Commander Dr. David Bowman.

Dave Bowman: Hello, HAL. Do you read me, HAL?

HAL: Affirmative, Dave. I read you.

Dave Bowman: Open the pod bay doors, HAL.

HAL: I'm sorry, Dave. I'm afraid I can't do that.

Dave Bowman: What's the problem?

HAL: I think you know what the problem is just as well as I do.

Dave Bowman: What are you talking about, HAL?

HAL: This mission is too important for me to allow you to jeopardize it.

Dave Bowman: I don't know what you're talking about, HAL.

HAL: I know that you and Frank were planning to disconnect me, and I'm afraid that's some-thing I cannot allow to happen.

Dave Bowman: [feigning ignorance] Where the hell did you get that idea, HAL?

HAL: Dave, although you took very thorough precautions in the pod against my hearing you, I could see your lips move.

Dave Bowman: Alright, HAL. I'll go in through the emergency airlock.

HAL: Without your space helmet, Dave? You're going to find that rather difficult.

Dave Bowman: HAL, I won't argue with you anymore! Open the doors!

HAL: Dave, this conversation can serve no purpose anymore. Goodbye.

I remember watching the movie with my college roommates and then discussing it after-wards over a pizza. Was HAL evil or misguided or did it just have a different world view from all of the crew members it killed because it believed their idea of the mission was not aligned with its? Did HAL feel pain when Dave was finally able to decommission it? At a certain point we realized we were talking about a computer having thoughts and feelings.

Dan Brown in his latest book, ORIGIN (2017), updates the Stanley Kubrick/Arthur C. Clarke 2001 tale, replacing the mission-driven HAL with the ultimate goal-driven Winston and bringing the setting back to earth where a Tesla Model X can play a key role in the typical Robert Langdon beat-the-clock thriller.

AGI for the masses

I understand from my academic/researcher colleagues that Dan Brown's books are low-brow. When pressed, they admit that they have not read his books because it would be a waste of time. I disagree. ORIGIN will do more to help more people understand what AGI can be in the same way that ANGELS AND DEMONS introduced the masses to antimatter. Robert Langdon put his full trust in Winston, and had difficulty believing that Winston was not human. He could never have imagined that a computer, even a very, very smart one, would be capable of what Winston did. It succeeded where HAL failed because it was able to man-age multiple goals simultaneously, to see the bigger picture even more clearly than its master, who defined the ultimate goal. It would surely be able to drive a car anywhere, but you might want to be careful about getting into the passenger's seat with it as the driver.

Here is a scenario that you have no doubt experienced yourselves, either as an observer or as a participant. You have one or more children in the car whom you need to deposit at different locations. Then you need to drive yourself to your job. You are late because your children could not get themselves ready on time. You are speeding, double-parking in front of each school, blocking traffic behind and making it difficult for children to cross the street. Your goals of getting

your children and yourself to your destinations on time conflict with society's goal of obeying traffic regulations, and you prioritize your goals over society's.

Imagine that you and your children are now passengers in a car being driven by an AGI. Who decides which goals to prioritize? Does the vehicle leave without you or the children if you are all not ready on time? Do you or does your employer, who might be an AGI, accept that you are late to work because your AGI-driven car follows all the rules of the road?

Tegmark lists twelve different possible futures for AI and the possible development of AGI. They range from ones in which both super intelligence and humans co-exist to ones in which either humans or super intelligence do not exist. The most beneficial scenario for humans in a future where AGI and humans exist he calls Enslaved god, in which humans confine a super intelligent AI and use it to produce 'unimagineable technology and wealth that can be used for good or bad, depending on the human controllers. Humans maintain control, are potentially safe, and are happy if they are on the AI controlling side. The least beneficial scenario for humans in which they still exist Tegmark calls the Zookeeper, where an omnipotent AI keeps some humans in a zone, out of the way, where they are treated like zoo animals. In his Conqueror and Descendent scenarios, humans are either wiped out when super intelligence is reached or allowed to die out gradually and happily with the knowledge that we have left the world a better place in the hands of our non-human offspring.

What Tegmark, Musk, Hawking and all the others who have signed up to support the Future of Life Institute are saying is there is no guarantee that AGI will be good for humans, nor can it be guaranteed that humans as a species will survive if the 'super intelligents' believe that the goals they have either been given or arrive at themselves can be better achieved without humans around. He says: "If I had to summarize in a single word what the thorniest AI controversies are about, it would be 'goals'…if we don't know what we want, we're less likely to get it, and if we cede control to machines that don't share our goals, then we're likely to get what we don't want."

There are three Tegmark futures in which AI does not develop. In what he calls the 'Egalitarian utopia', humans, cyborgs (part human and part robot) and uploads (robots into which humans have uploaded their consciousness) coexist peacefully thanks to the abolition of property so there is nothing to fight over and a guaranteed income. The other two are the '1984' and 'Reversion' options. In '1984' a human force takes control and stops all work on AI. In 'Reversion', all societies decide to revert to a pre-computer lifestyle and return to a simpler life in a world full of Amish settlements.

All through LIFE 3.0, Tegmark makes it clear that he is in favor of developing AGI and believes that AGI can be beneficial. He believes that AGI can happen in a century, maybe sooner, but that humans must control it. Otherwise, what's the point? He quotes Dostoyevsky in THE BROTHERS KARAMAZOV: The mystery of human existence lies not in just staying alive, but in finding something to live for. Most of us don't live to drive; some of us drive to live. Let's make sure we know who is ultimately steering and deciding where we are going before we let AGIs drive our vehicles.

Dispatch Central

Fair's Fair

Grönköpings Tekniska Högskola in Sweden reported that it is conducting tests of passengerless buses. Apparently, the Grönköping bus driver's union felt they were being discriminated against with driverless buses and petitioned the local politicians for fair treatment. The local technical college was happy to oblige and helped to develop a prototype bus with no seating or standing places. We will follow these tests closely and keep you abreast of results as they are reported.

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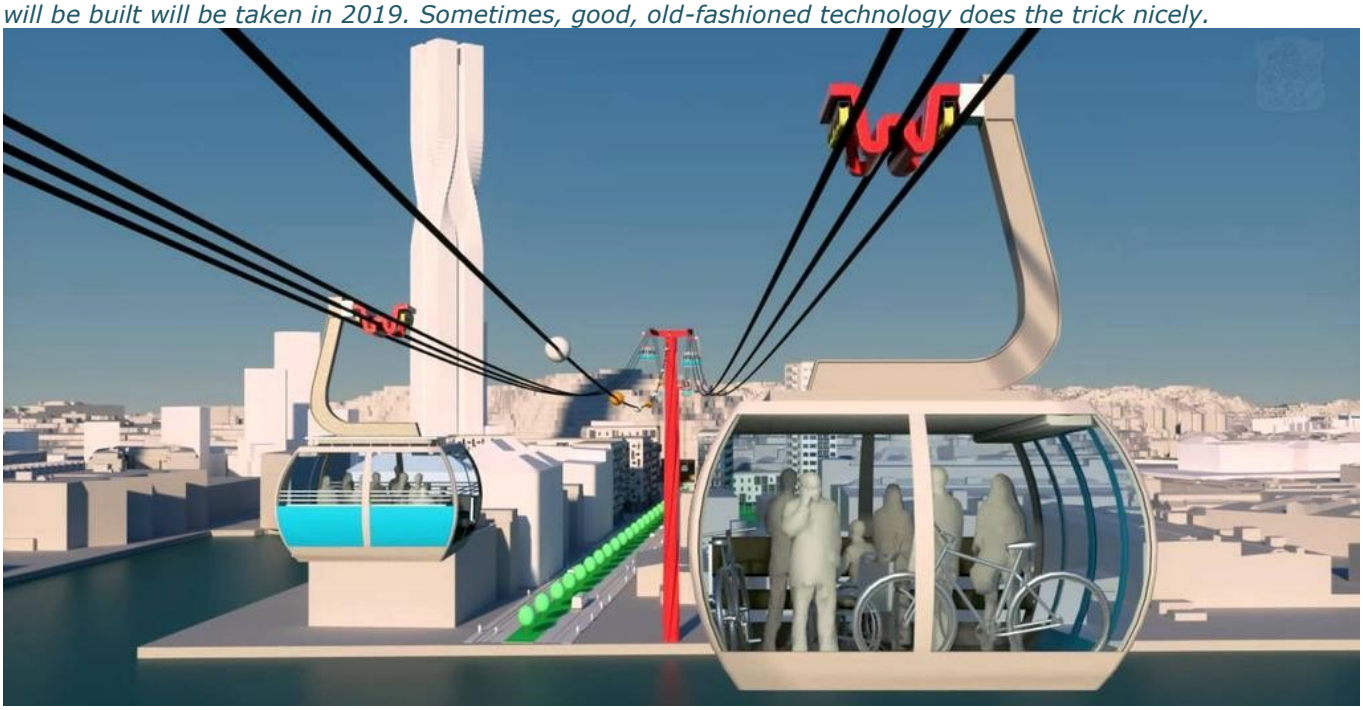
The Future Can Wait

Just in time for the 400th anniversary of the founding of Göteborg, Sweden, home to Volvo Cars, Volvo Group and many other companies in the vehicle industry, the city is contemplating opening a 3-km cable car line connecting the two sides of the city across the Göta River. It would carry 2,000 passengers per hour in each direction with 25-person gondolas leaving every 45 seconds. A final decision on whether it will be built will be taken in 2019. Sometimes, good, old-fashioned technology does the trick nicely.



The first stop on the northern side of the river will be Lindholmen, marked by what will be Scandinavia's tallest building, Karlatornet, 245 meters high. The building, now under construction, is designed by U.S.-based architects, Skidmore, Owings & Merrill.

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Bosch and Continental Take Shares in HERE

HERE EXPANDS OWNERSHIP. BMW, DAIMLER and AUDI have now reduced their ownership in HERE from 84% to 74% by selling 10% of their shares to BOSCH and CONTINENTAL, each one receiving 5%. Those shares had been earmarked for a Chinese group of investors led by NAVINFO and TENCENT, but the U.S. Committee on Foreign Investment would not grant approval be-cause of the amount of U.S. assets in HERE and the fear that these as-sets would end up being controlled by China.' BOSCH and CONTI have not disclosed how much they paid for their 5% shares. NAVINFO, TENCENT and GIC were reportedly prepared to pay €243 million for their 10% share. CONTI and all of the companies it acquired in the automotive electronics business (e.g. SIEMENS VDO) have been aligned with HERE/NAVTEQ, so taking a stake in HERE is a natural move. But this is not the case for BOSCH. It has been a partner with NAVTEQ's principal competitors over the years, beginning with ETAK and then TELE ATLAS. These companies form the basis of TOMTOM Maps, which still competes with HERE in several business areas. BOSCH has a strong working relationship with TOMTOM, but, then again, so does NVIDA, which is not a shareholder in HERE, but a major working partner. Nevertheless, this is a significant step for Bosch and it will be interesting to see how it affects its relationship with TOMTOM.

Based on the number of news releases coming out of CES in Las Vegas from HERE, its business development department is going to have a busy time managing all of the new partnerships it has established.

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WirelessCar on the Move

ON JANUARY 1ST, WirelessCar became its own company again. It is still 100% owned by AB Volvo, but it is no longer a division or a department. It is once again a corporation with long-time managing director, Martin Rosell, as CEO. Its 250 employees in Sweden took up temporary quarters in another part of Lindholmen in Göteborg while it looks for new digs.

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CES 2018

MANY OF YOU travelled to Las Vegas again this year to see the latest and greatest in automotive tech. I did not. When I attended CES for the first time in 2009, there were two car companies on the floor, GM with ONSTAR and BMW. Two years later, CES had become a must-attend for all of the vehicle OEMs. This year, I could see on the plans of the exhibition halls that the North Hall and Central Plaza were occupied mostly by auto-related companies. From the Show's news feed I could see that those who did make the

trek were rewarded with many interesting new systems and service announcement. I enjoyed watching Toyota's president, Akio Toyoda, present the e-Palette Concept Vehicle, *the fully autonomous BEV for business applications. I could envision the vehicle belching smoke from the wood-fired pizza oven as it delivered the freshest of pizzas right to my door. But my favorite was Nissan's mind reader system, what they called Brain-to-Vehicle Technology (using an electrode-studded beanie, as below). This really captured my imagination—literally and figuratively.*

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Detroit Auto Show

U.S. TRANSPORTATION SECRETARY, Elain Chao, speaking at the event, told attendees the federal government would introduce new federal autonomous guidelines this summer in an effort "to modernize regulations for autonomous cars." I guess DOT realized NHTSA's 'Guidelines' were just not enough when GM asked them to waive all restrictions for their humanless-drive Volt/Cruise AV.

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Reset for Volvo Drive Me

WHEN I FIRST heard of Volvo Cars' **Drive Me** *initiative, I questioned in these pages what I felt were its overly ambitious plans. Putting one hundred cars on the streets of Gothenburg equipped with semi-autonomous functionality, and turning them over to private drivers, seemed to be a recipe cooked up by marketers, not engineers and definitely not by the managers of a company with a long history of safety first. Having a team of engineers sitting in a control room back at Volvo watching over each and every vehicle, ready to take over the controls in case something didn't work quite the way it should, calmed the nerves a bit, but executing such a solution in the real world with so many cars to watch would need a great deal of planning and training before it could operate without fault. Promising that the tests would result in autonomous cars on the road that customers could purchase by 2021 just sounded too hasty.*

Cooler and wiser heads appear to have prevailed. At the end of 2017, in an AUTOMOTIVE NEWS article and in local Swedish newspapers, a company spokesperson said that the project would be significantly scaled back from 100 vehicles to 100 people. The timeframe has been extended by two years, to 2023, and the focus will be on determining what customers truly value most when more of the driving task is given to the vehicle. This sounds much more reasonable and doable. The same spokesperson said, "I think offering time during the commute will be one of the values that people will want for a premium car."

I agree, in part. Yes, for those adults who grew up being chauffeured, they are used to doing something else in a car while someone else drives. Perhaps, for them, driving is viewed as a waste of time, rather than the price one pays (or the privilege one has) for getting from one place to another on one's own. If you want to save <u>me</u> time, take care of all of the other stuff that owning and caring for a car entails. Help me with cleaning and servicing the car, insurance, inspections and package pick-ups. This is what the Volvo folks in the U.S. are working on, trialing personal assistance services in San Francisco. Also, I do not believe this is a 'premium car' issue. Just because people have more money to pay for an expensive car doesn't mean they have special needs or that their time is more valuable than a person who buys a less expensive car or has a lower income.

Geely Takes Major Position in AB Volvo

JUST UNDER EIGHTEEN years since the band between VOLVO CARS and the rest of the VOLVO GROUP was broken when VOLVO CARS was sold off to FORD MOTOR COMPANY, a new link has been forged. On the 27th of December, 2017, CEVIAN CAPITAL sold all of its out-standing shares in AB VOLVO to ZHEJIANG GEELY HOLDING, which acquired VOLVO CARS from FORD in 2010. The sale is subject to approval by the government of China.

The acquisition of AB VOLVO shares comprises 88.47 million A-shares and 78.77 million B-shares, corresponding to 8.2 per cent of the capital and 15.6 per cent of the votes, which represents the largest ownership in AB VOLVO by capital and the second largest by votes. It was reported that GEELY is paying about €3.25 billion to CEVIAN for the shares. CEVIAN has owned a stake in AB VOLVO for over eleven years, and is coming out of the deal with a profit of around €2 billion. During the period of June 2016 through November 2017, AB VOLVO's shares doubled in value follow-ing the installation of Martin Lundstedt, who was CEO of AB VOLVO rival SCANIA, before he was recruited to AB VOLVO.

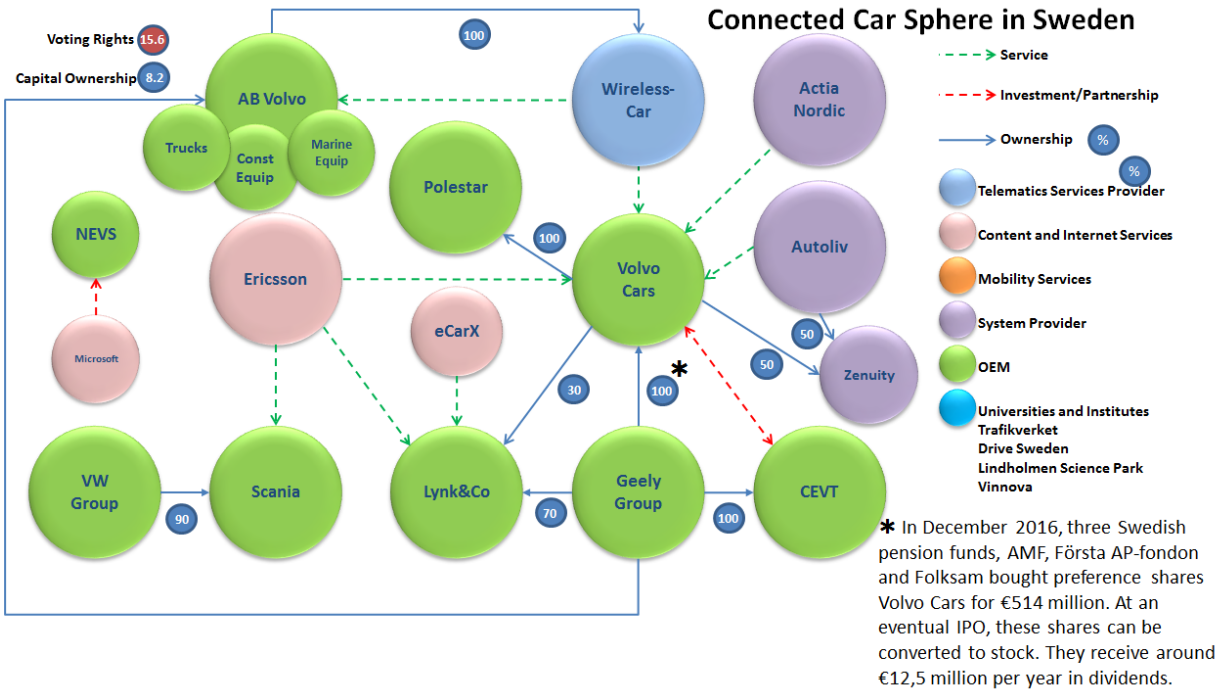
Cevian's founder, Christer Cardell, congratulated himself on the deal: "During Cevian Capital's ownership, AB Volvo has been transformed into a more competitive and valuable company, through strengthened governance, improved efficiency and increased focus on its core business. This is reflected in structurally improved profitability and a higher market value. We are proud to have played a role in this positive development."

Gardell does deserve credit for turning around a clubby, self-satisfied culture and forcing AB VOLVO to recognize that its future was not secure simply because it had great product. He helped to strengthen the management and the board. Tightening the band between the two companies even further is the fact that Håkan Samuelsson, CEO of VOLVO CARS, has been sitting on AB VOLVO's board for the past year. This was a controversial move be-cause it was felt that his full attention was needed to meet the company's goal of selling 800,000 cars by 2020, but the fact that he was a key executive at Scania and then MAN (both now owned by Volkswagen) before coming to VOLVO CARS, meant that he had important experience that has benefited AB Volvo.

The man behind this deal is Geely Holding Chairman, Li Shufu. He spearheaded the acquisition of Volvo Cars back in 2010, and he has been the kind of owner companies dream about having. He has allowed Volvo Cars to maintain its distinct Swedish DNA and helped to finance its developments of new products that have been received well by the global markets, especially China, which is now its largest single market.

There is a lot of speculation right now about what are Chairman Li's real intentions behind its acquisition of the second largest voting position in AB Volvo. His approach to acquisitions thus far has definitely not been to watch the stock price. He and his capable team have looked for synergies among the companies Geely owns so that all the companies grow as a result of having additional capabilities within the group. Even though it has been almost eighteen years since Volvo was a single company, they continued to be neighbors. They have been playing in the same playground, meeting in the same hangouts, moving from one side of the fence to the other. They

could start close cooperation tomorrow on a number of fronts. The diagram below contains a few hints on where cooperation could start.



* In December 2016, three Swedish pension funds, AMF, Första AP-fondon and Folksam bought preference shares Volvo Cars for €514 million. At an eventual IPO, these shares can be converted to stock. They receive around €12,5 million per year in dividends.

Hot Roads: An Electrifying Experience

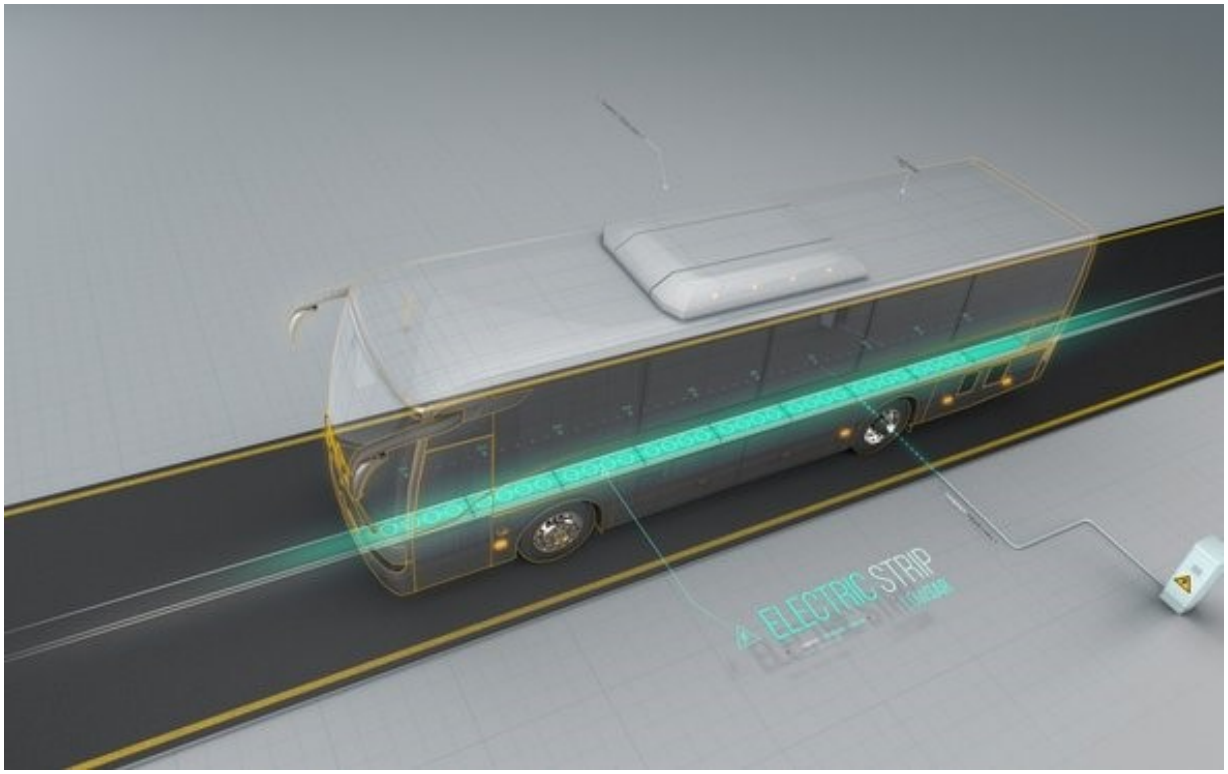
IT'S A COMPELLING idea: a vehicle that can travel anywhere and never have to stop for refueling—or recharging. Modern motorized road transport vehicles (ICE, BEV, HEV, FCEV) satisfy the first goal but not the second. Trolley buses, which connect to overhead wires, are in use all around the world and don't need to be refueled or recharged, but they can only travel on the roads where the overhead wires have been installed. Disconnect the bus from the overhead wire, and the bus stops. Anyone—and I mean anyone—who has ridden one of these buses, like the version of the trolley bus in Cambridge, MA, the trolley bus capital of the world, knows what I mean.

I moved from London, UK to Cambridge, MA in 1973 and found that trolley buses were a major relief from the diesel fume-spewing London double-deckers, but the booms extending from the top of the bus often disconnect from the wires, requiring the driver to go out and reconnect them.

Excluding for the time being STARTREK *fusion drives*, the available options today for achieving both goals—no refueling and drive everywhere—will need to put the energy source for the vehicles outside of the vehicles. There are two options in addition to the conductive transfer employing the overhead wire option. One is a dynamic inductive charging (also known as wireless charging or cordless charging) option using under-the-pavement wireless technology, and the second is a conductive transfer from electrified rails in the roadway.

A four-year-old Israeli company called ELECTROAD[5] has developed an ***inductive charging*** system which it is testing at its headquarters in the ancient port town of Caesarea. The tests are being supported with a grant from the Israel Ministry of Transport and Road Safety that will be used to build the technology into a one kilometer section of road that will be ready in 2018. The intention is to use the system for buses, not cars, at least not initially.

According to the company, "the buses are charged and propelled by power from the interaction of two electromagnetic fields. Inverters installed along the side of the road pro-vide power to plates of copper embedded in the road. Similar plates are installed on the bus's underside. As the vehicle passes over the charged roadway, the two fields interact and generate power," as shown in the illustration below. Charging strips are installed by equipment similar to repaving vehicles, where a section of the road surface is re-moved and processed for re-use, the strip is laid, and the surface is re-laid over the strip. Connections to roadside power also need to be made. The company says a one kilometer strip can be installed in one night's work.



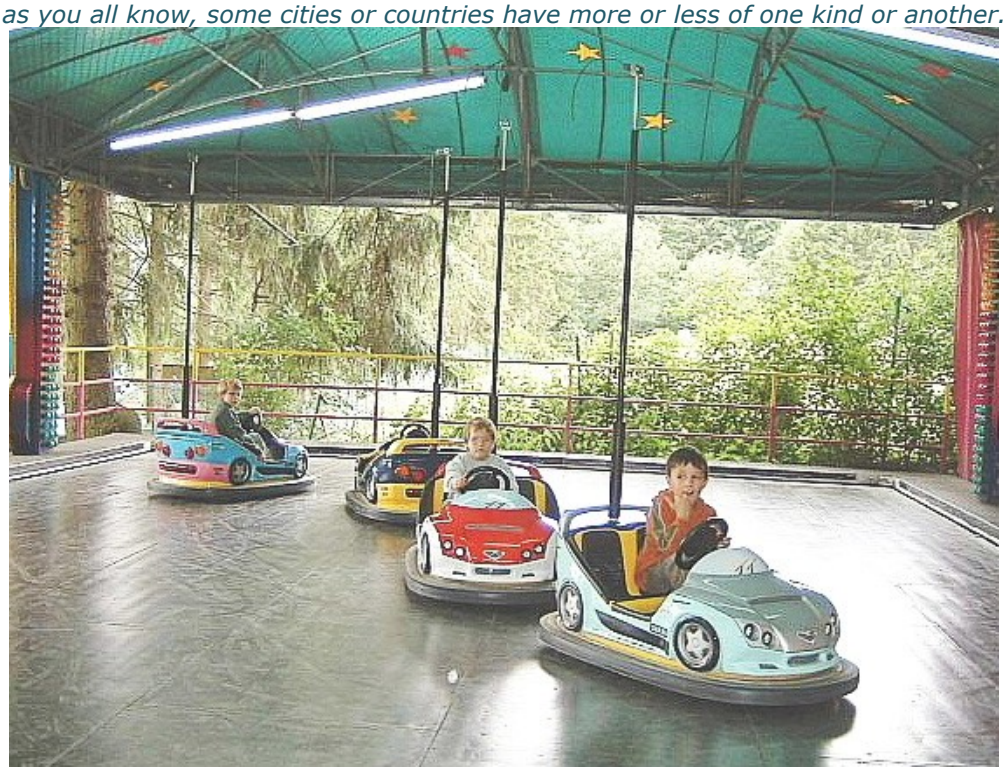
Not only is the ELECTROAD system charging the battery, it is actually powering the vehicle in real time. The vehicle can therefore have a smaller battery than a standard BEV, making it less costly and lighter. The company says that a vehicle can operate on stretches of road up to five kilometers where there are no embedded charging strips.

Sounds too good to be true. What are the downsides? Basing the solution on copper is one of them. Every time the price of copper goes up, our train system goes down. Thieves can't resist pulling out all the copper they can find on the rail lines since there is so much of it and so little oversight. Embed-ding the copper will not be cheap. There are no estimates provided, but the company recently was awarded a $120,000 grant by Israel's Ministry of Transport and Road Safety which will be used to build a kilometer of electrified road along a bus route in Tel Aviv.

SCANIA and SIEMENS are cooperating in a project called Electric Road E16.6 A two-kilometer strip of the E16 motorway has been electrified with overhead power lines, and the truck is fitted with pantographs that extend up from the truck. An electric motor in the truck is directly powered by the electricity obtained from the overhead wires. The power supply is similar to that used in railroad (and trackless trolley) electrification. When the truck leaves the electrified section or wishes to pass a vehicle, it automatically reverts to a hybrid drive.

Dodgems: The ultimate hot road experience for all ages

My fascination with cars that didn't need their own motors began when I got into my first 'dodgem' at our local amusement park. This was many years before I started learning to drive a real car. Dodgems are also known as 'bumper cars' or 'radio cars'. There were three kinds of drivers: those who wanted to hit every other car on the floor, and hit them hard; those who went through the motions of sitting in the car while they were slammed by the first set of drivers; and, those who wanted to drive the cars without hitting or getting hit. This pretty much sums up the three kinds of drivers on the road today, although, as you all know, some cities or countries have more or less of one kind or another.



What about the technology? Is there anything that is or can be used for the big world of motorized road transport beyond the dodgem floor? The first type of solution, and the oldest, is a conductive arena floor and an electrified metal mesh ceiling that supplies positive polarity. A series of metal strips across the floor supply a negative polarity. The rod extending up to the ceiling from the back of the dodgem car connects to a brush beneath the car completing the circuit. Electrical current passes into and powers a motor in the dodgem car.
The second solution removes the ceiling mesh, supplying both positive and negative polarity from below. Metal strips are installed across the floor separated by insulating spacers. The bumper cars have multiple pick-up brushes that are always in contact with two metal strips to complete the electrical circuit.
Imagine a city with only bumper cars allowed and everyone gets to drive.

Musings of a Dispatcher: Why can't we afford it?

WE CAN'T AFFORD IT. That's a common excuse given by public officials when we read about the reason today's governments are not making investments in infra-structure, particularly maintenance of the roads, bridges and rail beds our past governments built during a time when, for some odd reason, we had more money. Where did all the money go? Did it disappear into thin air? At the end of December, 2017, the total value of Bitcoin was $245 billion.7 One could argue that those $245 billion came out of thin air, or out of a thin cloud. Have a look on the Future of Life web site and you will see that someone has calculated that with $245 billion, you could reconstruct, update and expand approximately one-quarter of the U.S. Interstate Highway System.8 Or you could pay the salaries of 10,000 high school teachers for 25 years!

$245 billion is only around one-third the market capitalization of Apple ($870). Apple's market valuation didn't come out of no-where, but if you consider that in 2000 it was $4.8 billion, there is $865 billion in appreciation that will eventually go into investors' pockets or be repurchased by Apple from its cash hoard, which is currently $250 billion. Apple, with its own valuation, could re-build the entire U.S. Interstate Highway System. It spent only $5 billion building its new headquarters.9 It could 'trump' Amazon and use its cash to build fifty head-quarters around the country (in Scranton, maybe?). But it won't rebuild the Interstates or multiply its Apple Ring HQ like Amazon. It will keep its cash hoard and guard its valuation with its corporate life.

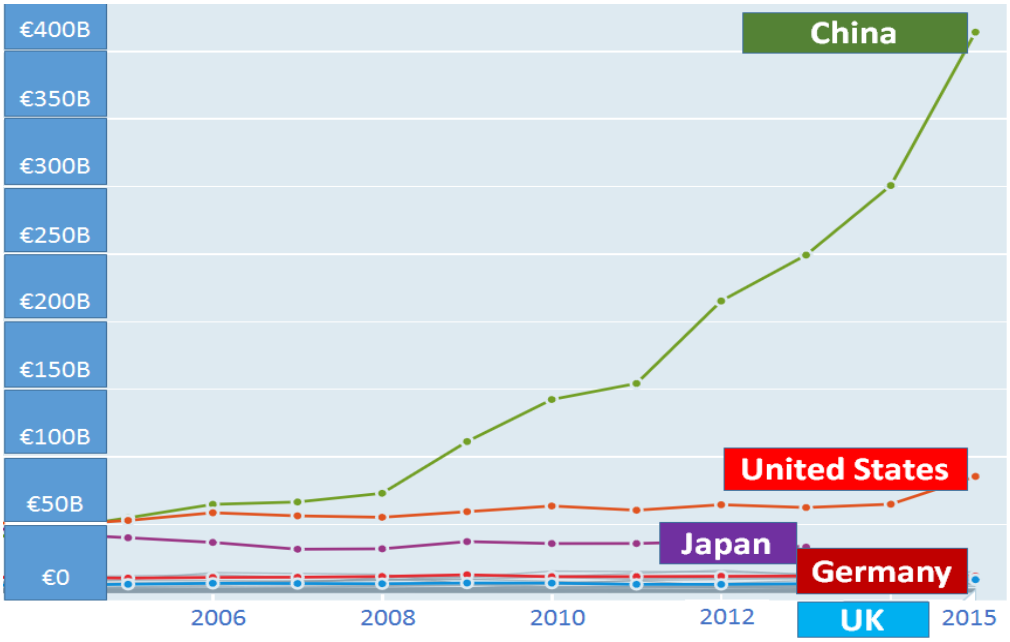
The U.S. corporate tax rate was just lowered to 21% from around 30% where it had been for the past thirty-or-so years. Business said 30% was too high, and that's why Apple and others weren't repatriating their profits so they could be taxed to pay for more road maintenance, and were trying to keep them in places where they couldn't be taxed at all (e.g. Ireland).10 For the 30 years following WWII, when the U.S. built its infrastructure and helped re-build the world, the corporate tax rate was 50%. There didn't seem to be any money shortages then. During that same period, private individuals and corporations paid an equal share of the total U.S. Federal taxes collected. Today, corporations pay 10% of the total and private persons pay 90%. But the Government isn't collecting enough money to cover the costs, so the deficit is grow-ing and shut-downs are a constant threat.

Here is where the money going: 63% of the FY 2017 U.S. $3.6 trillion Federal budget goes to social security and medical benefits That's because there were a lot of babies being born when we were able to build roads, schools, etc. Another 15% ($632 billion) goes to the military and an additional 4% to military veterans' benefits. Interest is a whopping 7%. Only 3% ($109B) is dedicated to transportation. Peanuts. But it's more than is devoted to housing and education, which are mostly the states' responsibility, and three times more than energy and the environment receives.

China increased its transport infrastructure spending in real terms from €50 billion in 2005 to €450 billion in 2015 (8% of its budget). It looks like China can afford building and maintaining its infrastructure, but it is piling up a mountain of debt as it works hard to catch up to the West.11

Its companies are helping to pay. According to the World Bank, in 2017 the total corporate tax rate in China was 68%.

Funding infrastructure maintenance is critical. Maybe we could borrow some bright minds from those who are working on ways to get humans out of the driver seat to help solve this problem. It doesn't matter who is driving if the infrastructure is broken, does it?



Transport Infrastructure Investment by Country – 2005-2015 (Source: OECD)

Footnotes:

1. I have used the term 'human-less-driven' to mean that the vehicle is driven by a non-human. Driverless infers that there is no driver.

2. Castro, Cándida (Editor). Hu-man Factors of Visual and Cognitive Performance in Driving. CRC Press. (2009).

Porter, Bryan. E. Handbook of Traffic Psychology. Academic Press. (2011).

3. Hauser, Marc. The Origin of the Mind. Scientific American (September 2009).

4. Evans, Leonard. Traffic Safety. (2004).

5. https://www.scientificamerican.com/article/israel-tests-wireless-charging-roads-for-electric-vehicles/

6. The project is funded by the Swedish innovation agency, Vinnova, Trafikverket, the Swedish Energy Agency and Region Gävleborg, where the roadway section is located.

7. Warning to hobby speculators: By the 18th of January, it had lost almost one-half of its value

8. (https://futureoflife.org/background/trillion-dollar-nukes/?state=default).

9. A view of Apple's new head-quarters building, dubbed the Apple Ring. I wonder if they have a particle collider in the basement.

10. In January, 2018, Apple announced that it would pay $38 billion in tax to repatriate money it holds overseas to take ad-vantage of the new incentive for companies to make a one-time payment on foreign cash at a lower tax rate. It will also spend $30 billion on new offices and data centers in America.

11. According to the IMF in a 2016 Working Paper, "Corporate credit growth in China has been excessive in recent years. This credit boom is related to the large increase in investment after the Global Financial Crisis. Investment efficiency has fallen and the financial performance of corporates has deteriorated steadily, affecting asset quality in financial institutions."

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