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Telematics Industry Insights by Michael L. Sena

THE DISPATCHER

IN THIS ISSUE

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How Important is Exact Localization for HAD?

Reactive Localization

Localization is often defined as the position and orientation of an object in relationship to a reference point or collection of reference points. In respect to common navigational tasks, the term localization most often refers to using visual cues and/or mapped information to relatively accurately define the position and orientation of an object moving through an environment during the pursuit of a general objective, such as transiting an area, or in terms of specific objectives such as finding a restaurant or determining the direction to a point of interest. Note that in these types of applications, localization is loosely defined, such as, "the restaurant is just up on the right." It is my opinion that the term ***Reactive Localization*** *better describes the implementation of the concept of localization in relation to HAD. I define Reactive Localization as the ability, during the traversal or occupation of a particular geographic environment, to highly accurately define the location and orientation of a specific vehicle/object as a component for calculating and implementing the desired manipulation of the vehicle/object to preserve its safety while effectively meeting a mission objective. Note that localization, in HAD applications, must be precisely defined as opposed to our earlier example of its use in common navigation tasks.*

In respect to HAD, the location of the object/vehicle should be defined by the use of highly accurate positional coordinates to define its bounding box (three dimensional) and buffer. Further, for optimal use in a HAD system, precisely localizing the vehicle/object will require the elimination of disparities between coordinate systems, map bases, clock error states and other potential measurement biases to allow for the preservation of the integrity of the vehicle/object during potential encounters with nearby vehicles and other real world objects.

Michael W. Dobson, Ph.D.

Road Data for Highly Automated Driving

I have asked Michael W. Dobson, Ph.D. to provide an explanation of the term 'localization' as an introduction to this article. Please see ***Reactive Localization*** *in the sidebar. Dr. Dobson is an internationally known and highly respected authority on all matters concerning geographic information. He began his career as Associate Professor of Geography at the State University of New York at Albany, teaching there from 1972 until 1985. He joined Rand McNally in 1986 as its Chief Cartographer, became VP of New Business Development and served as Chief Technologist until 2000. Since then, he has been an independent advisor to businesses and governments.*

THERE ARE MANY companies now working on driverless functionality for vehicles. Most of them have toned down their hyperbolic announcements about full driverless capability being just around the corner, and developers have admitted that the problem was much more difficult and complex than they thought when they started working on the problem, some as long back as the early 2000s with the DARPA Challenges. Waymo, a subsidiary of Google, was among the first companies to begin to try to commercialize driverless cars. It has been very cautious about making predictions concerning the technology's maturity and its ability to move from test to full operation. It is purposely limiting the roads on which its vehicles operate to those it has thoroughly mapped. It has put a literal fence around a section of Chandler, Arizona outside of which its cars will not stray. Waymo has also put in place back-up procedures to assist their driverless vehicles when problems occur. Waymo cars have a very good record of operating in driverless mode.

TESLA's CEO, on the other hand, continues to promote its Autopilot system as almost ready, close to perfect and able to be used almost everywhere. Unfortunately, TESLA cars have shown that when drivers hand over control of their vehicles to Autopilot, their cars tend not to perform all that well, even when driving on restriced access highways.

What is it going to take to make vehicles fully driverless, at least on some of the types of roads and in some of the places where motorized vehicles are driven today? Reading through the material provided by companies developing driverless solutions, and talking with the people working on these solutions, it is clear that the dominant theme is how various types of sensors, combined with very intelligent algorithms will crack the code for turning robots into better-than-human drivers. Some swear by LiDAR while others, Elon Musk among them, simply swear at LiDAR.[1] Some believe that RADAR is an absolute necessity, while others believe that it is sufficient to have multiple cameras. Conversations about driverless cars and trucks have focused on the hardware on one side and artificial intelligence/deep learning/neural networks on the other. There is precious little discussion on maps of any sort or on road data.

I am interested in exploring here the extent to which exact localization of the vehicle improves the driverless driving task and how that localization is performed. Is it sufficient to use road edges, painted road markers and permanent road fictures, or are more detailed road feature data and physical characteristics of the roads critical to the driving task, to 'reactive localization' as defined by Dr. Dobson? What makes the main difference between keeping the vehicle moving safely forward or winding up hopping over a drainage culvert and an open manhole cover and ploughing into a tree, fatally injuring the occupants and bursting into a flaming inferno?

1. LiDAR is an acronym of 'light detection and ranging'. It is a method for determining ranges (variable distance) by targeting an object with a laser and measuring the time for the reflected light to return to the receiver. LiDAR can also be used to make digital 3-D representations of areas on the earth's surface and ocean bottom, due to differences in laser return times, and by varying laser wave-lengths.

Driverless car developers have attempted to mimic good driver behavior, using sensors and cameras instead of eyes and software instead of brains to process information gathered by the vehicle on the environment and to control the movement of the vehicle: start, accelerate, decelerate, brake, stop, turn, park. Don't rely on traffic lights; look both ways at stop signs; don't drive in the breakdown lane; keep at a safe distance in front and behind; stay in your lane and don't change lanes without double-checking; know your stopping distance.

Driving is a full-time 360^{o} task

Humans, whether we are walking or driving, do not look down at our feet as we move along a path or road. We look ahead and scan the surroundings.[2] The first lesson that new drivers have to learn is to pick up their eyes from the road immediately ahead of the vehicle and to keep the eyes moving all the time. Back mirror, left side mirror, right side mirror, shortly ahead, far ahead. You have to sense that there could be a car coming up from behind, a door

2. https://www.driving-tips.com/understanding-your-surroundings-while-driving/

opening from a parked car, a deer springing out from the trees. The reason why talking on the phone while driving is dangerous, even in hands-free mode, is that it breaks our concentration on the scanning task. We concentrate on what we are saying and what we are hearing, and our gaze gets stuck on the middle of the road ahead.

At the same time as we are scanning, we are performing the main task of driving: keeping the vehicle within our allocated portion of the road and not infringing on the other drivers' spaces while moving at a safe speed for the road on which we are driving. This task is easier for us when there are clear lane markings and the road is brightly lit. It is more difficult when the road and its lane markings are covered by snow, when it is dark and there are no street lights or when there are heavy rains. Driving at night on a two-lane undivided road during a snow storm or heavy rain when there is no car ahead leading the way is one of the most difficult driving tasks there is. It takes the full concentration of the driver. In such conditions, the field of focus is narrowed to the immediate environs of the road, you need to slow down to be able to react to other vehicles, pedestrians or animals entering your allocated space. (See sidebar for where accidents occur.)

It's a lot for a human to learn—not hitting other vehicles, people or things, not being hit, and getting ourselves and our passengers to where we want to go—but we have managed surprisingly well. As long as we don't drive under the influence of alcohol or drugs, don't speed, don't fall asleep at the wheel, don't get distracted by fellow passengers or distract ourselves by playing with the instrument panel controls, navigation systems or our mobile phones, and especially not believing companies that claim they can deliver a car that drives itself, we can stay out of trouble.[3]

Proprioception, Kinaesthesia and Multi-sensory Integration

There is a reason we can do all of this. It's the same reason we can make music on an organ with our two hands and two feet or touch type on a computer keyboard while we think of what we are writing, as I am doing now. It is called 'proprioception' or 'kinaesthesia'.[4] It is the sense of self-movement and body position. It is called the 'sixth sense'. Proprioception is the body's ability to sense its location, movements and actions, and is the reason we are able to move freely without consciously thinking about our environment. Without the appropriate integration of proprioceptive input, it would be impossible to drive an

Insurance Institute for Highway Safety - U.S. Statistics

In 2019, the rate of crash deaths per 100 million miles traveled was about 2 times as high in rural areas as in urban areas (1.66 in rural areas compared with 0.86 in urban areas). From 1977 to 2019, the rates decreased by 62 percent in rural areas (from 4.35 to 1.66) and 63 percent in urban areas (from 2.35 to 0.86).

In 2019, 70 percent of large truck occupant deaths, 68 percent of pickup occupant deaths, and 55 percent of SUV occupant deaths occurred in rural areas, whereas more than 70 percent of pedestrian and bicyclist deaths occurred in urban areas. Motorcyclists were more likely to die in urban than in rural areas.

In 2019, single-vehicle crashes accounted for 53 percent of crash deaths occurring in rural areas and 54 percent in urban areas.

In 2019, crash deaths in rural areas were less likely to occur on interstates and freeways and more likely to occur on collector roads and local roads.

In 2019, 71 percent of crash deaths in rural areas occurred on roads with speed limits of 55 mph or higher.

In 2019, 16 percent of crash deaths in rural areas occurred at intersections, compared with 33 percent in urban areas.

3. Professor Alain Kornhauser lumps all of these negative activities into the category of 'misbehaviors'. In his words, if humans didn't misbehave when they drive, there would be far fewer accidents and deaths.

4. 'Proprioception' is from Latin *proprius*, meaning 'one's own', 'individual', and *capio*, *capere*, 'to take or grasp'. Thus to grasp one's own position in space, including the position of the limbs in relation to each other and the body as a whole.

https://en.wikipedia.org/wiki/Proprioception

automobile because a motorist would not be able to steer and use the pedals while looking at the road ahead.

How does it work? Close your eyes and keep them closed. Place your left hand somewhere. Now, grab your left thumb with your right thumb and forefinger. If you can do it, your proprioceptors are firing on all cylinders. Humans have both conscious proprioception and non-conscious proprioception. The former is communicated to the cerebrum by a sensory pathway of the central nervous system that conveys sensations of fine touch, vibration, two-point discrimination and position from the skin and joints. The latter is communicated to the cerebellum via a nerve tract originating in the spinal cord. It carries position information from muscle spindles and Golgi tendon organs. There is a lot more to it, but the bottom line is that we are able to perform basic movements in space starting at birth, and we gradually learn to perform more and more complex tasks.

Humans don't need a map to drive, or do they?

We learn to walk and run. We sense the surface beneath our feet without having to look at it. We sense everything and everyone around us and we move without bumping or being bumped into. In addition, we learn how to go places. Our brains are spatial. From approximately the age of eighteen months humans begin to develop congnitive mapping skills to organize our little worlds. These so-called brain maps help us to find our way around our homes and then our neighborhoods and gradually increasingly large areas beyond our local environs. Our spatial awareness is connected to a region of the brain called the hippocampus. This area of the brain allows us to orient ourselves in space and gives us an awareness of direction. On top of this, the hippocampus makes it possible to link an experience to a specific time and place in what is called an 'episodic memory'. These maps help us organize, store and retrieve memories. Wasn't it at this corner that I had to turn left to get to school? Isn't it here that I have to be on the lookout for that bully?

A study of London licensed taxi drivers in 2001 by researchers at UNIVERSITY COLLEGE LONDON found that those who had passed *THE KNOWLEDGE* exam had larger-than-average hippocampus.[5] The exam tests the taker's ability to memorize Greater London's 25,000-plus streets and thousands of places of interest and landmarks. The researchers observed the prospective exam-takers for four years as they prepared for the test. During this time, the drivers allowed themselves to have Magnetic

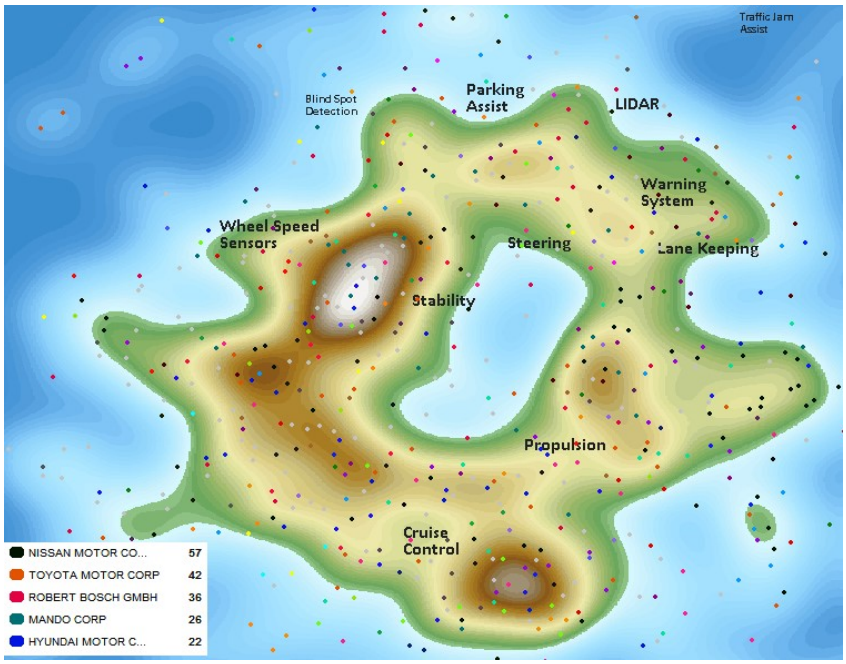
London's licensed taxi drivers have to rely on their own knowledge to navigate the streets of one of the world's largest and most complex network of streets. Bees take this a step further and communicate their spatial knowledge with others in their hive. Apart from humans, they are thought to be the only creatures known to do this. Using the position of the sun as a datum, they share distance and direction to nearby food sources with other bees with their 'waggle dance'.

5. https://royalsocietypublishing.org/doi/10.1098/rstb.2008.0288

Resonance Imaging (MRI) scans of their brains. Those who passed showed a "sizable increase" in the hippocampus compared to those who failed.

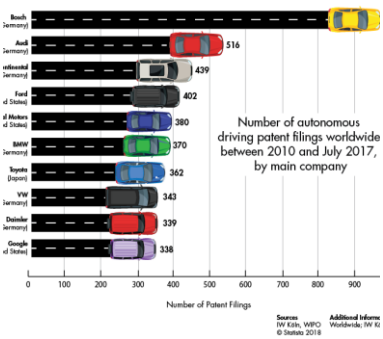
Let's just fix the robots up with a hippocampus

Can't we just plug a hippocampus simulator into a driver robot and perform a little linear time-invariant system analysis to get the proprioceptors to make the reactive localization transfers? Sounds like a plan. Maybe that's what some of the companies attempting to develop driverless vehicles are doing. If they are, they are keeping it a secret. I found the interesting gravity model diagram below in a report called Patent Landscape Report on Autonomuos Car-Control Mechanism/ Driverless-Car (I have spelled the report title as it is written). It is produced by a company in India called GRIDLOGISTICS.[6] It shows who is taking the autonomous/driverless car patents and what areas they address.



I did not find anything here or in the other documents about simulating proprioceptors and the hippocampus functions. It's possible that if I searched through all of the patents, some 3000-plus, I might find some references to simulating human behavior, perhaps under the steering or lane-keeping categories. Most of what I found is related to how cameras, LiDAR, RADAR, inertial sensors and ultrasonic sensors provide images to the software, and how the software tries to figure out whether the objects are moving or stationary and what they may do to get in the vehicle's way. The chart to the right lists the ten companies with the most patents in 'autonomous driving' up to 2017. Google was #10.

6. https://gridlogics.com/patent-landscape-report-driverless-car/



Autonomous Driving/Highly Automated Driving Patents up to 2017

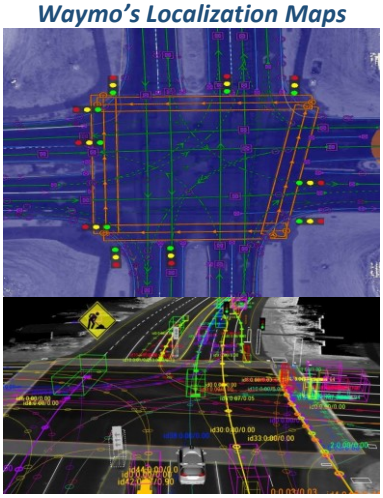
The music goes down and around, whoa, and it comes out here.

Waymo, and to one extent or another all of the companies developing driverless solutions, uses four sub-systems for moving its driverless cars from A to B: perception, localization, prediction and planning.[7] Most of the attention is on perception. That is where all the sensors do their job. Localization is the task of taking the sensor data and positioning the vehicle in its correct place on the Planet and its exact place on a road. In some cases, as with Waymo, it is aided by GNSS. Waymo says it also uses Google Maps as part of its localization task, as well as for navigation. Prediction is Waymo's forte. It released documents several months ago describing how its software can 'anticipate human behavior' using recurrent neural networks. So it predicts what drivers, cyclists and pedestrians will do in vehicles in the vicinity of its vehicles, and takes action accordingly. Based on these predictions and the action it decides to take, it plans trajectories. Planning is based on what the software judges as the best path to take to stay on the road, avoid collisions and reach the desired destination.

7. https://heartbeat.fritz.ai/how-googles-self-driving-cars-work-c77e4126f6e7

The images to the right are provided by Waymo. The top one is an example of the maps it produces to guide the software that drives its vehicles. It is a two-dimensional view, but the maps are fully three-dimensional. There are detailed lane marking and centerlane vectors, street edges, traffic signs and signals, pedestrian crossings and much more. Waymo says that before it puts any of its cars on a road, its mapping team produces detailed maps of everything in the area where the cars will drive, their operational design domain, so that when its cars are being driven the on-board sensors are able to compare what they are seeing with what has already been mapped. Having already mapped every road in this way, every point can be assigned an accurate geographic coordinate. In the lower image, in a bird's-eye, real-time view with the Waymo vehicle in the lower/center of the image, vehicles, cyclists and pedestrians with which the Waymo vehicle shares the road are shown as rectangular prisms. For each vehicle, a probable course vector is calculated by the Waymo software.

Waymo's Localization Maps



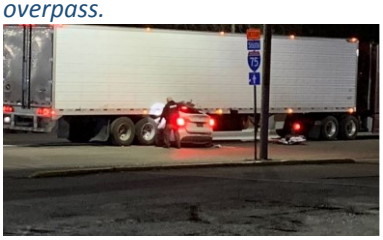
Here is how Waymo describes the operation of their software in one of their patents:

"A method for controlling a vehicle, the method comprising: detecting an object external to a vehicle using one or more sensors; using a processor, determining a classification and a state of the detected object; predicting a likely behavior of the detected object based on behavior

data for other objects having a classification and state similar to the detected object; and providing a command to orient the vehicle in a position and velocity based at least in part on the likely behavior of the detected object.
(SYSTEM AND METHOD FOR PREDICTING BEHAVIORS OF DETECTED OBJECTS; United States Patent Application 20120083960; April 12, 2012.)

Waymo uses three sensor technologies to guide its vehicles: an enhanced vision system (cameras), RADAR, and its own LiDAR system. The LiDAR system sends out pulsed laser beams and uses the reflections to map objects up to 200 meters away. It is very good at distinguishing between a pedestrian, a vehicle or an overpass versus a tractor trailer (see sidebar). LiDAR has some limitations, including high cost, high power consumption, inability to distinguish between colors, weakness in distinguishing objects that are very close, and poor performance in rain and dusty environments because particles can interfere with wavelengths. RADAR comes in handy to detect the distance of an object. It operates in cloudy weather conditions and at night. It has a longer range than LiDAR. However, its shorter wavelength makes it difficult to detect small objects and cannot provide a precise image of an object.

This is a big truck driving under an overpass.



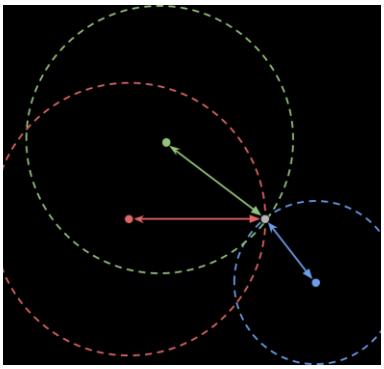
This is a Tesla that tried to pass under a big truck after having run through a stop sign.

Cameras are the mainstay of driverless vehicle sensing. Waymo incorporates them with its other sensors. TESLA has now decided to rely only on cameras, rather than incorporating RADAR with cameras.[8] It is argued that cameras work the same way as human vision works. TESLA has said that with its eight cameras positioned around its vehicles, it can create 'superhuman eyes' that have much better acuity than biological eyes.[9] MOBILEYE, which is owned by INTEL and which supplied the original Autopilot visual sensing technology to TESLA (until Musk summarily fired them in 2016 after the first Florida deadly crash with Autopilot), is developing a twelve-camera sensing system. Cameras are also much less expensive than LiDAR and RADAR, do not require adaptations for vehicle applications so they are basically off-the-shelf. And they are small enough to be easily incorporated into the design of a vehicle. Nevertheless, video images from eight or twelve cameras, all being collected simultaneously, generates quite a lot of data that must be processed. It's one thing to say that you have the power to create superhuman anything; it's quite another to prove it. So far, no one has.

8. In May, 2021, Tesla announced that it was removing its RADAR sensor for its Autopilot system in Model 3s and Model Ys and using a totally camera-based system in the North American market.

9. https://www.autopilotreview.com/lidar-vs-cameras-self-driving-cars/

Trilateration is the technique that is used to position the vehicle correctly on the road.[10] By knowing the distance to three objects, you can calculate where you are. If those objects are positioned



10. https://www.alanzucconi.com/2017/03/13/positioning-and-trilateration/

geodetically accurately, then the result of your trilateration will provide you with a geodetically correct position for your vehicle—assuming that your distance measurements are precise. And you need to do all these calculations while the car is constantly moving. Is there any wonder why Waymo has so few bang ups in Chandler as its cars lumber around at under 40 miles per hour?

While this may give the impression of a high degree of precision, it is approximate. Sign posts are not perfectly vertical, guard rails can be bent in accidents, cameras can be blocked by snow. There is no mention from Waymo of using features that have a fine level of detail, that do not sway in the wind and are either present naturally or have been placed there for a purpose, and I have not found any other companies developing solutions similar to Waymo who say anything about the physical nature of the roads.

Roads have personalities – Do we recognize them?

Why aren't we using the more physical characteristics of the roads to enhance reactive localization? Can pavement type, road surface texture, color variations, seam patterns, patching materials and methods and other physical characteristics of the roads make a difference to improving reactive localization?

I learned that roads had distinct personalities at an early age. It was our Sunday family drives that taught me the lesson. Sometimes these rides had destinations, like to grandparents or aunts' and uncles' houses. Sometimes they were just drives. Whenever we passed a county line, the noise level in the car changed. Dad said it was the county roads departments making sure the main roads leading into their jurisdictions were always freshly paved to remind the people who lived there why they should stay there rather than move to the neighboring county. On long drives to New York City, we experienced the same thing when we crossed over the New Jersey state line, only the better stretch of road lasted longer. After a while, it was back to the normal patchwork of old and new surfaces, cracks and potholes. If I closed my eyes, I could follow the entire journey by the sound of the car's wheels meeting the pavement.

Four years ago I was given a consulting assignment to study and report on the specific characteristics of major roads in the U.S. that would affect the collection, modelling, labelling, processing and eventually the use of the data for highly automated driving systems. One objective of the report was to determine if there are

any patterns in the presence of certain types of road characteristics that might affect the creation of map data for highly automated driving. In the photo to the right, the truck in the passing lane heading toward the top of the image has a very different set of conditions to the van in the passing lane heading in the opposite direction. Patching tar covers the yellow line along the center barrier and the lane markings for the truck, while the yellow line and dashed lane markings are clearly visible for the van. In the close-up image to the right, the positioning of the yellow and blue road reflectors relative to the double yellow line could aid localization accuracy, just as the cracks running across the yellow lines could do so as well.

Making a big deal out of cracks in the roads

RoadDB LLC is a company whose business is based on looking carefully at details on and around roads. It was incorporated in November 2019, but work on the concept behind the company began many years previous to its founding. Its initiator is T. Russell Shields, best known for having founded Navigation Technologies, which became Navteq and is now Here. In RoadDB, he has gathered a team of experts, among them Yuka Gomi, Richard Shuman and James Herbst, who were instrumental in Navteq's success. RoadDB is a subsidiary of Ygomi LLC, a company established in 1999 by Russ Shields and Yuka Gomi.

In January of this year I listened to Russ give a presentation of the vision of RoadDB at the *Drive Sweden*'s *Forum and Annual Meeting*. He explained that the goal of this company was to provide software which generates, updates and manages road databases, and software for localization of vehicles for highly automated driving products. Russ made a strong point that it was highly automated driving products for series production vehicles (SPVs) he was talking about. These are vehicles purchased by consumers and businesses for normal driving, as distinguished from vehicles that operate within geofenced areas and have as their goal to replace professional drivers. SPVs need to work everywhere at all times.

Because series production vehicles need to work everywhere and at all times, ROADDB's focus is on delivering data that can meet the extremely demanding requirements of HAD for localization accuracy and up-to-dateness at a cost that is low enough to be affordable to the wide market, said Russ. Its solution relies on real-time sensor fusion and an in-vehicle road database. It uses low-cost, standard sensors that are already in the vehicle, such as a forward-facing monocular camera, vehicle movement and other standard sensors (e.g., an inertial measurement unit for measuring wheel ticks). These are complemented by image processing software in the vehicle with vehicle localization and difference detection. Off-board server software operated by ROADDB assesses differences reported between what is senses and what is stored on-board to build and update the road data on the central server. There is a feedback loop between vehicles and servers to continuously refresh the road data with data being sent back to the vehicle using cellular communications. HAD systems that work under all conditions, everywhere, must know where the vehicle is (vehicle localization), what to expect in the immediate environment, and what is ahead, beyond the reach of the sensors. This is what Russ explained to those listening to his *DRIVE SWEDEN* presentation:

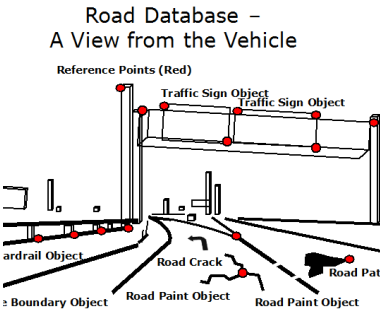
"The only approach to automated driving is true vehicle-sourcing that has very complex software in the production vehicles, very complex software in the server to consolidate the updates, and separate very complex software to receive the updated road data in the vehicle and deliver it to the vehicle control software. This has to be a fully closed loop with no human intervention. The vehicle control software is concerned with where the vehicle is in the lane on the road and what is around it. It does not care about geodetic coordinates. It also does not use any form of GNSS for the highly accurate localization. The road data is nothing like a map for navigation. It is many thousand person-years of software development and massive verification and validation."

Can't we just use the landmarks?

Those who are developing highly-automated driving solutions, and who have shared their general localization solution, are all doing basically the same thing: employing vision sensors to measure distances away from specific landmarks along the roads on which the cars are driving, and then using the results of the measurements to trilaterate the position of the vehicle. They claim that they can achieve single-digit centimeter-level accuracy. ROADDB is essentially saying that using sign posts, distance markers, and other types of physical landmarks is not sufficient to

achieve a consistently high enough level of 'reactive localization' to ensure that the moving vehicle will be able to maintain a correct position on any type of road on which it will be driven. ROADDB achieves 10 cm relative accuracy and better than 50 cm absolute accuracy, both laterally and longitudinally, with frequently updated data and coverage wherever ROADDB-equipped vehicles drive.

ROADDB processes changes that are recognized on-board and then sends only the change data to the server. The diagram to the right shows the type of data that is collected by ROADDB. A road crack or a patch in the surface provides a high precision data point to be used by the on-board systems to position the vehicle. If the particular road crack or patch was detected by another vehicle, it will have already been transmitted to all vehicles driving in the vicinity of it and will not be transmitted back to the central database. If it is new, the updated data is then transmitted back to the vehicles as incremental updates and only to the vehicles in the affected area. This minimizes data transmission costs from the vehicle and reduces the amount of post-processing that is necessary at the central server. It is crowd-sourcing, but it is processing only new data of the kind that is needed for precision driving.



Data Collected by RoadDB

An added benefit to systems that are based on a combined on-board and off-board approach is that temporary data, such as icy road conditions, road closures or other dynamic data can be delivered to vehicles within affected areas. Also, seasonal data, such as reduced speed limits at summer activity areas such as camping places and beaches. What about when roads look like they do in in places like Sweden four-to-six months of the year, with roads covered by snow and sand? That's where all the other visible reference points come into play.

Will robots roam everywhere or just somewhere?

There aren't signs and curbstones and traffic lights everywhere, especially not within 'eyeshot' of a camera, LiDAR or RADAR sensor. There aren't landmarks that can be mapped and then recognized with certainty on back roads and country lanes. GNSS is not exact enough and always available so that it can be used reliably everywhere and at all times. Waymo works because it recreates an image of the 'somewhere' where their cars will drive and then continuously, in real-time with its cloud-based system, monitors the location of those vehicles. But Waymo is not designed to work

everywhere. There is no business model for Waymo on back roads and country lanes. It is not a series production vehicle solution.

TESLA's Autopilot has to be for SPV, but it doesn't yet work 'somewhere' and definitely not 'everywhere' because its cars don't know what's up ahead and around the bend, and they do not have sufficient data for highly accurate reactive localization. They need to see everything, especially lane markings, and with the removal of RADAR and the absence of LiDAR, their cameras and ultrasound systems must perform all the sensing tasks in all types of conditions. Their on-board software needs to process what they see and hear. If their processing is wrong, if it really is a tractor trailer crossing the road and not an overpass, then bad things will happen.

So, in Waymo, we appear to have an increasingly reliable but expensive driverless solution for 'somewheres', and, in TESLA, a less expensive but not-so-reliable solution for 'everywheres'. Waymo's reactive localization works well because it has plenty of data to function with, drives its cars at a slow enough speed to allow its algorithms to do their job and has chosen a geographic location for its first big test that has no weather challenges (except the heat). How do we get reliable AND inexpensive driverless capability for SPVs that must operate everywhere, at higher speeds and in all types of weather? It is probably by using some parts of Waymo's solution, with pre-mapping of visible position references, but at a level of detail that is closer to what ROADDB is providing. Re-creating an exact image of the world (i.e. everywhere) that is constantly kept up-to-date will require thousands of times more processing power than what it currently being used for Chandler. It is also probably using some of TESLA's solution, with on-board processing of sensed objects, but including off-board data for referencing to fixed objects such as overpasses.

Until we can get the localization formula just right, no cars or trucks should be allowed outside of restricted areas where authorities have given their permission to a reputable company (i.e. accessible to the judicial system and with deep enough pockets to pay the inevitable lawsuits) to make controlled tests, and where the people in the area have given their consent to share the roads and adjacent walkways with cars that do not have a driver.

Dispatch Central

The *irresistible force paradox*: What happens when an irresistible (unstoppable) force meets an immovable object? One response to this paradox is that if a force is irresistible, then by definition there is no truly immovable object; conversely, if an immovable object were to exist, then no force could be defined as being truly irresistible.

Driverless dreams meet insurance reality

WHAT HAPPENS WHEN an unstoppable force meets an immovable object? This is referred to as the 'irresistible force paradox'. There are many people who believe that driverless cars are an inevitable, irresistible and unstoppable force. Investment analysts and technology promoters have convinced governments that driverless cars are part of the price of the ticket to play in the super league of countries. They are urging legislators to propose and support legislation that would allow unlimited testing of driverless cars on all types of roads at all times of day.

Against this is the immovable object of liability concerns, and these concerns are given voice by the liability insurance industry. Who is at fault if a car being driven by a robot hits another vehicle or a pedestrian or damages property? Is it the car manufacturer, the robot software manufacturer or the robot hardware manufacturer? Is the owner at fault if he has not updated the software with a recommended fix to correct a problem that has been announced by the car manufacturer, or does the OEM retain responsibility for ensuring that its horses cannot leave the stable if they have not been properly groomed?

On the 6th of September, 2017, a U.S. House of Representatives bill drafted by Representative Robert E. Lotta (Republican from Ohio) was passed. It was officially called the *SAFETY ENSURING LIVES FUTURE DEPLOYMENT AND RESEARCH IN VEHICLE EVOLUTION ACT*, or *SELF DRIVE ACT* for short. The bill had bipartisan support, and, if passed by the Senate, would have established the federal role in ensuring the safety of highly automated vehicles by encouraging their testing and deployment. The bill defined a 'highly automated vehicle' as *"a motor vehicle, other than a commercial vehicle, that is equipped with an automated driving system capable of performing the entire dynamic driving task on a sustained basis"*.

One of the main reasons this bill was introduced was to preempt individual states from enacting their own laws regarding the design, construction or performance of highly

automated vehicles or automated driving systems—unless those laws were identical to the federal standards. Two important conditions in the bill are that the Department of Transportation (DOT) must require safety assessment certifications for the development of highly automated driving systems, and that manufacturers of highly automated vehicles must develop written cybersecurity and privacy plans for such vehicles prior to offering them for sale. During testing, certain safety and testing standards are waived.[11]

11. DOT must: (1) inform prospective buyers of highly automated vehicles of the capabilities and limitations of such vehicles; (2) establish the Highly Automated Vehicle Advisory Council to, among other things, develop guidance regarding mobility access for the disabled, elderly, and underserved populations; (3) require all new passenger motor vehicles less than 10,000 pounds to be equipped with a rear seat occupant alert system; and (4) re-search updated safety standards for motor vehicle headlamps.

Everything didn't go exactly to plan

Senators reviewed the bill passed by the House in 2017, but did not pass it before it adjourned in 2018. For more than a year, Republican Senator John Thune, who chairs the Senate Commerce Committee, and Senator Gary Peters, a Michigan Democrat, led the effort to win approval for the bill, and said they were determined to get it through in the Senate's next session. It did not pass in 2019 or in 2020 either, and it looks doubtful that it will pass in 2021. What's the holdup? Insurers' worries over liability. When OEMs tried to move things along by suggesting language that would prevent consumers from suing or forming class action cases, instead submitting disputes to binding arbitration, the lawyers and safety groups raised the red flags. A group of fifteen consumer advocacy groups wrote a letter on the 17th of May to leaders of the House Energy and Commerce consumer protection subcommittee opposing mandatory arbitration. They are concerned that commercial operators, like Uber, will one day be operating the bulk of driverless vehicles and will include clauses in their terms of service—which riders will never read—absolving them of any and all responsibility for accidents.

The Alliance of Automobile Manufacturers, a trade group, called the bill's failure "a setback for the development and ultimate deployment of potentially life-saving technologies, and leaves many unanswered questions on how this technology will be regulated." Another group, the Center for Auto Safety, said "the threat of litigation has served consumers as an important check on auto manufacturers for decades".

Missy Cummings, Director of Duke University's *Humans and Autonomy Lab*, warned that Congress should not rush to add new regulations for self-driving (driverless) cars, or reduce the regulations that are currently in place, while the technology is still in development. "I think the experimental exemptions that we have are fine," she said.

Insurers in the UK have similar reservations

The ASSOCIATION OF BRITISH INSURERS (ABI) and THATCHAM RESEARCH are concerned about the allowing automated lane keeping systems (ALKS) on UK roads, and they expressed their concerns in a government review of ALKS conducted at the end of 2020. For one thing, they don't particularly like the word 'automated'. Both groups want to slow down the process and allow more time for testing and developing better ways to help consumers fully understand what the systems can and cannot do and when they should not be used. They claim their tests show that ALKS "do not replicate what a competent and engaged human driver can do".

Thatcham said the ALKS it tested could meet only two out of twelve of its principles required to guarantee safety.[12] It should definitely not be called 'automated driving', rather it should be labelled 'assisted driving'. This is because drivers believe the term 'automated' means they can completely disengage from the act of controlling the vehicle. An example is Autopilot. Even though Tesla cautions drivers to keep their hands on the wheel and watch the road, it has been shown that many drivers disengage completely.

In April of this year, the UK Department for Transport announced an open consultation for proposed changes to *The High Way Code* to allow ALKS on UK roads by the end of 2021.[13] DfT is determined to allow vehicles fitted with ALKS to be legally defined as 'automation' under the *Automated and Electric Vehicles Act 2018* (*AEVA 2018*). The technology must be approved in the UK and it must be shown by the ALKS supplier that there is no evidence challenging the vehicle's ability to self-drive. Cars using ALKS may not drive faster than 37 miles per hour (60 kph).

There is a solution to the omnipotence paradox. The paradox is based on two incompatible premises. An unstoppable force and an immovable object cannot exist simultaneously. For a force to be truly unstoppable it would have to have infinite energy. For an object to be truly immovable, it would have to be able to resist any force. So far, in the U.S. insurers have shown themselves to be immovable, while in the UK, the government has decided that driverless technology is unstoppable.

https://www.visordown.com/news/industry/abi-and-thatcham-warn-against-automated-driving-plans

12. Twelve Principles of Safe Driving
1. User support: info, naming and user obligations
2. Location specific:
3. Safe driving: ADS capability and behaviour
4. User monitoring
5. Secondary tasks
6. Starting automation
7. Using automation
8. Ending automation
9. Collision avoidance and protection
10. Cyber resilience
11. Collision data
12. Sustainability
https://www.thatcham.org/what-we-do/automated-driving/12-principles-automation/

13. https://www.bbc.com/news/technology-56906145

Tesla takes steps to expand Tesla Insurance

TESLA ANNOUNCED IN November last year that it intends to "create a major insurance company", stating that insurance could one day represent 30-40% of the company's revenue. In August 2019, it began selling a basic form of automobile insurance under the name *Tesla Insurance* to owners of its vehicles in California. Here is what it says on its web site:

"Tesla Insurance is a competitively priced insurance offering designed to provide Tesla vehicle owners with up to 20% lower rates, and in some cases, as much as 30%. Tesla Insurance offers comprehensive coverage and claims management to support Tesla owners in California and will expand to additional U.S. states in the future. Tesla Insurance offers a convenient monthly payment with no hidden fees or charges."

When Musk announced his plan, Warren Buffett of BERKSHIRE HATHAWAY, which has substantial holdings in the insurance industry, said: "It's not an easy business. The success of the auto companies getting into the insurance business is probably as likely as the success of the insurance companies getting into the auto business."

The promise of a lower price was just that, a promise. The average insurance cost for a Model 3 with *Tesla Insurance* is $2,233, which is $315 more than the average car insurance rate nationwide. The difference is larger with Model S and X. The reason is not a mystery. TESLAS require special equipment to fix them so there are only a limited number of shops that can repair them. Insurance premiums include rental cars, travel reimbursements, repatriation reimbursements in case an accident or breakdown occurs out of state or in another country. Fewer repair shops means greater distances to travel and increase these costs. To attract customers in spite of higher costs, TESLA offered additional services—of course, for an additional cost. These include:

- Autonomous vehicle owner coverage - *Tesla Insurance* will provide liability coverage for property damage or bodily injury if your car gets in an accident while operating in autonomous vehicle mode.
- Wall charger coverage - Up to $3,000 available for loss or damage of the power charger as long as the damage is not from a manufacturer defect or negligence.
- Electronic key replacement - Covers up to $500 per loss of your TESLA electronic keys. Coverage is limited to two claims per policy period.
- Auto loan/lease gap insurance - The coverage will pay for the difference between the vehicle value versus what is owed in car payments if your TESLA is a total loss after an accident.
- Cyber identity fraud coverage - This coverage pays up to $15,000 in digital identity fraud losses per occurrence and up to $30,000 per period if your information is compromised.

Insurance is a Promise

When you buy car insurance you are actually selling your risk to someone else, the insurer. The entity that buys your risk guarantees that if you have an accident, if damage is caused to your vehicle or to another vehicle, if you are injured or you injure someone else, whether or not you are at fault, that entity will cover your eventual costs over and above an agreed sum which you retain as 'self risk'. The costs may be minor, like fixing a dent or replacing a damaged windshield, or they may be major if there has been loss of life, you are at fault and you are sued. You expect that the company that sells you insurance will be there when it is time for them to do what they have promised to do, and you expect them to do what you have paid them to do. You do not expect them to go out of business and leave you uninsured; you do not expect them to find ways of absolving themselves from meeting their contractual obligations; you do not expect them to change the conditions of your contract.

TESLA has not revealed information about the uptake rates of its California product, but two years after its start, Elon Musk is now saying that TESLA is ready to compete with the real major car insurance companies, including ALLSTATE, GEICO, PROGRESSIVE and STATE FARM. In March, it applied to state regulators in Illinois, Texas and Washington for permission to sell car insurance. Insurance regulators in Illinois and Texas have approved the rates and policies for Tesla Insurance.[14] The goal, the filings say, is to "enable a technologically advanced customer focused insurance product."

14. https://www.spglobal.com/marketintelligence/en/news-insights/latest-news-headlines/latest-tesla-insurance-offering-more-evolutionary-than-revolutionary-62027080

Governments have plans for your data, Elon

Those financial analysts who see more $s, €s and CNYs rolling into TESLA's coffers, pumping up its stock to new heights and paying for their kids' college educations believe that TESLA can use all of the data it is constantly collecting from its customers' vehicles, combine it with the personal data that it has on all of its customers, add data that it can acquire from third parties and have everything every car insurance company can only dream about to charge the lowest rates to the best drivers and the highest rates to the worst. They believe that TESLA can capture the bulk of the business for its own vehicles by sweetening the deal with special offers, especially covering the use of Autopilot which will likely prove to be more and more problematic to insure.

One lesson we have all learned during TESLA's relatively short history: don't try to short sell the company. Those who did have lost their shirts and their kids' college tuition. But this time there is a stronger immovable force than even the insurance companies: government. And, especially in Europe, not just government, but the Leviathan.[15] What happens to TESLA's plans if it must share all the data it collects from its vehicles with all insurance companies, as the European Commission is planning to legislate? TESLA then has no competitive advantage. Musk may try to shrug this off, believing it will never happen, but the chances are very good that it will, precisely because of this very example, a car company having total control over the data being produced by the vehicle and using that data to offer a service that customers have had the freedom to buy from third parties.

15. See Musings of a Dispatcher: The Leviathan Syndrome in the May 2021 issue of The Dispatcher.

Car companies have tried and failed to become a force in car insurance. One after the other they have sold or closed the business. Insurance companies don't need to carry capital-intensive inventory, to build factories, to pay for raw materials. They invest the premiums they collect so that when they need the money to pay out on claims, it is there. You can't base your insurance business

on selling more cars, getting government contracts to send astronauts into space or to flip more burgers at your hamburger joint.[16] There will be times when you won't sell more cars, the space contracts to competitors and your burger flipping competitors eat your lunch, but there will still be accidents and breakdowns. TESLA may prove the exception, but since its success is totally based on it controlling the flow of data from its customers, it will have major problems if that flow is no longer controlled by TESLA.

Bits and pieces

Tesla's China orders were halved in May, or were they?

FIRST THERE WAS an announcement made by REUTERS on the 3rd of June that TESLA's sales in China were down by 50% compared to April.[R] Sales were 18,000 in April, but only 9,800 in May, said the announcement. April was down from March when it sold 35,478 cars in China. TESLA's share price slipped by 5% after the announcement on May sales. China now accounts for 30% of TESLA's sales and is second only to the U.S. in importance for the company. TESLA has come under pressure from Chinese regulators over complaints by consumers that TESLA is not a safe car, but the fact that TESLA is a U.S. company and the U.S. is increasing pressure on China both politically and economically is also playing into how the authorities in Beijing deal with TESLA. TESLA made no comment on the report.

Then, on the 8th of June, a report by the CHINA PASSENGER CAR ASSOCIATION stated that TESLA had sold 33,463 cars in May, up 29% from April's 25,845 units. The only number that matched the REUTERS announcement was the sales for March. On this new report, the stock fell 0.25%. I have found no explanation for the first report stating that sales had tanked, and which caused the share price to dive. After the new numbers appeared, TESLA backers lauded the company's handling of the "shaky public relations issues with in China".

Please come back to me again, my little darlings

IT WAS fun while it lasted. No driving the kids to school and yourself to the office; leisurely breakfasts and a run after the last Teams or Zoom meeting for the day. Now the Spoil Sport in Chief of Volvo Cars has ordered all office workers back to the mother ship that is docked in Torslanda, Göteborg. Of course, the 'essential workers' have been there all along, watching over the paintbots and weldbots and putting on the finishing touches to cars as they ended their tour along the assembly line. It will be staggering starting times for employees, ostensibly to reduce pressure on

16. A few years ago, TESLA applied for building permits to construct a "restaurant and Supercharger station" in Santa Monica. Musk talked about a 50s-style diner. The project stalled, but this year new building applications were submitted. However, the new application was for a charging station without the restaurant. Now it seems that Tesla has gotten serious about it. The company recently applied for three new trademarks in the restaurant industry. The trademarks were taken out for "restaurant services, pop-up restaurant services, self-service restaurant services, take-out restaurant services." The trademarks include one for the word 'Tesla' and the other for its T logo. The last is for the stylizing of the word 'Tesla'.

public transport, but most employees will be taking their cars and filling up the parking lots that surround all of its facilities.

It is odd timing since the vacation period starts soon and there is usually a shut-down of the assembly line for re-tooling and maintenance for a few weeks during the summer. Schools in Sweden are now closed for the summer break until mid-August, so parents of younger children generally time their own vacations with the school break. The Swedish health authorities are recommending that companies allow as many of their workers as possible to continue to work remotely, but leave the decision on whether to call workers back to the office up to the individual companies.

Volvo Cars is not alone in its quest to bring back the troops.[17]

Stealthy BEVs shall be no more

HAVE YOU EVER been surprised by an electric car that has silently snuck up on you as you are about to cross the street? The EU has seen a safety need in electric vehicles that the car companies have ignored which it will be filling on the 1st of July this year. Two years ago it passed a Regulation on the Sound Level of Motor Vehicles (EU 540/2014) that legally prescribes the mandatory installation of a so-called AVAS (Acoustic Vehicle Alerting System) into battery electric and hybrid-electric vehicles. All cars that are type-approved after that date must contain a device that makes a sound that can be heard, just like a normal car.[18] It must be active up to the speed of 20 kilometers per hour. Above that speed, the car can be silent.

It was the organizations for the visually impaired, as well as bicyclists and dog owners, who pushed for the regulation. Similar efforts are being made elsewhere.[19]

Why have traffic deaths risen during the pandemic?

A NEW STUDY from the U.S. National Highway Traffic Safety Administration (NHTSA) estimates that 38,680 people died on U.S. roads in 2020. This was a 7.2% increase over 2019 and a thirteen-year high, in spite of the fact that the number of vehicle miles driven in 2020 was down 13.2%. What's going on? Here's what NHTSA says:

"NHTSA's research suggests that throughout the national public health emergency and associated lockdowns, driving patterns and behaviors changed significantly, and that drivers who remained on the roads engaged in more risky behavior, including speeding, failing to wear seat belts, and driving under the influence of drugs or alcohol. Traffic data

17. James Gorman, the CEO of MORGAN STANLEY, one of the top investment banks, said at an investing conference in June that it's time for the bank's New York workers to start coming back to the office now that more people are getting vaccinated for Covid-19 and life is slowly returning to normal. "If you can go to a restaurant in New York City, you can come into the office. And we want you in the office," Gorman said. "By Labor Day, I'll be very disappointed if people haven't found their way into the office," he said, adding, "Workers can't expect to get their New York salaries if they continue to work remotely. If you want to get paid New York rates, you work in New York," Gorman said. "None of this 'I'm in Colorado...and getting paid like I'm sitting in New York City.' Sorry. That doesn't work."

18. Type Approval describes the process applied by national authorities to certify that a model of a vehicle meets all EU safety, environmental and conformity of production requirements before authorising it to be placed on the EU market.

19. The U.S. government has finally set its "quiet cars" mandate in stone, Reuters reports. Automakers will have until September 2020 to ensure that their electric vehicles make noise at speeds below 30 kilometers per hour (18.6 mph), and they must be 50 percent compliant one year earlier than that.

VISION AUSTRALIA and BLIND CITIZENS AUSTRALIA cited findings from a 2018 MONASH UNIVERSITY survey of the blind and low-vision community in their submissions to a New South Wales Government inquiry into electric buses. The survey found 35 per cent of respondents reported having experienced either a collision or near-collision with an electric vehicle.

indicates that average speeds increased throughout the year, and examples of extreme speeds became more common, while the evidence also shows that fewer people involved in crashes used their seat belts."

That's why traffic-related deaths are up, but why are Americans engaging in more risky behavior? The jury is still out and the final verdict has not been delivered, but the *U.S. Department of Transportation Office of Behaviorial Safety Research* has speculated on some reasons. One is that the risk-averse people stayed home while the risk-seeking people went out and drove around like crazy. They drove faster as a result of fewer cars on the streets and highways, did not use their seatbelts and drove intoxicated on alcohol and drugs. Among seriously and fatally injured drivers at the five trauma center study sites, more than 29% in the period July 19 to September 30 had measurable alcohol in their systems, 26% testing positive for the presence of cannabinoids and over 13% positive for opioids.

If risk-seeking people want to kill themselves, they should not be allowed to take innocent people with them. If the risk-seekers don't want to wear seatbelts, that should be their prerogative, but they should not have the same insurance benefits as those who do. Mandatory alcohol/drug locks and mandatory speed limiters should have been installed on all cars years ago. All roads should have guardrails separating opposite lanes of traffic to prevent suicide head-on collisions. The list of things that could be done to protect non-risk-takers is long.

The Milan-Monza Auto Show shows how it can be done

TWENTY-ONE MONTHS. That's how long it had been between when the last motor show was held in Europe and when the MiMo Auto Show was held from June 10-13 in Milan and on the Monza racetrack nearby. That last show was the IAA in Frankfurt (aka the Frankfurt Motor Show) in September 2019. I reported on that show and said that it might have been the last of all motor shows due to the protests inside and outside the exhibition halls. The organizers of the biannual event decided to move it to a more car-friendly city, Munich, where it is planned to be held September of this year.

A track was laid out in Milan's Piazza del Duomo where the latest models were paraded before enthusiastic onlookers and the press.

MiMo (**Mi**lan-**Mo**nza) was a small event, hosting 63 brands in downtown Milano and on the Monza racetrack. The show was free, but the organizers were able to obtain a count of participants by tracking the number of interactions with the displays

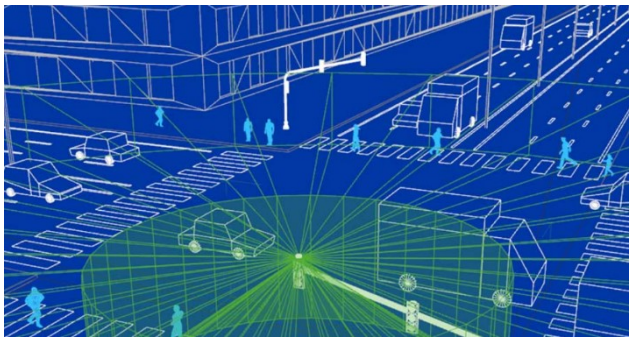
where viewers used QR codes to look at specifications and characteristics of the models. There were 57,835 individuals who scanned the display codes. In addition, there were 76,264 Internet page views of model data.

This is a great example of how a motor show can be conducted. It was done with the full cooperation of the city of Milan, who have a strong interest in supporting their automotive industry, while at the same time making it an entertaining event for the residents and visitors. Photos of the event show most people walking around wearing face masks, which will probably become a permanent fixture for some time to come at large, public events.

Using stationary LiDAR for intersection data

WHAT IF A community could monitor traffic flow in an intersection, day or night, including not only vehicles on the road but pedestrians, cycles and scooters, and it could do it 24 hours/day, in all weather conditions all year round. On top of this, what if it could do it without being accused by its citizens of invading their privacy and Big Brother tactics that accompany the setting up of cameras. This is what VELODYNE is now promoting as a useful application of its LiDAR technology with its *Intelligent Infrastructure Solution*.

My first experience with LiDAR (Light Detection and Ranging) was almost twenty years ago as an adviser to INTERMAP TECHNOLOGIES, INC., a pioneer in the use of the technology in remote sensing and the production of digital terrain models. Eric DesRoche and his team were working on a method for creating data quickly and inexpensively to be used in ADAS applications for fuel reductions in large commercial vehicles. I saw the potential for LiDAR then and have watched its application areas grow with its improvements in range and resolution as its costs have decreased.



Among other applications, VELODYNE's *Intelligent Infrastructure Solution* is being used to analyze near-miss situations at intersections. Camera-based solutions require longer processing times to be called 'real time' and are challenged by severe weather and darkness. LiDAR data can be interpreted immediately.

Velodyne's Journey

David Hall founded VELODYNE Acoustics in 1983 as an audio company specializing in subwoofer design and production. He invents and patents industry-changing technologies that allow VELODYNE to dominate the subwoofer space.

VELODYNE's experience with sensors for autonomous vehicles began when David Hall, in the early 2000s saw the writing on the wall in large Chinese characters. The audio ecosystems was moving to china, and he was going to have to find a new business area. He decided it would be LiDAR. He entered a vehicle in the 2004 DARPA Grand Challenge, a driverless car race sponsored by the DEFENSE ADVANCED RESEARCH PROJECTS AGENCY. None of the cars finished the race, but Velodyne's new life as a LiDAR manufacturer was started. In 2007, Team Tartan Racing's vehicle (CARNEGIE MELLON) took 1st place in 2007 with a Velodyne HDL-64E mounted on top.

Hall stepped down as CEO of Velodyne in January 2020, replaced by the company's chief technology officer Anand Gopalan. But he remained executive chairman of the board, steering the company's major financial decisions, until earlier this year.

Last summer, Velodyne became the latest mobility technology company to go public via a reverse merger, or SPAC. The company struck a deal to merge with special purpose acquisition company Graf Industrial Corp., with a market value of $1.8 billion.

https://velodynelidar.com/blog/it-began-with-a-race16-years-of-velodyne-lidar/

LiDAR revolutionized the production of digital terrain models.

Musings of a Dispatcher: Who Crosses the Bridge?

The Climate Change Universe

Climate change deniers and some climate change agnostics believe that there is no bridge that needs to be built.

Some climate change believers and agnostics put their faith in human ingenuity and are sure we will be able to build the bridge if and when it is really needed.

Climate change alarmists are certain we will need a bridge, have decided on the date when it will be needed and want everyone to start working on building it right now.

The fourth group include those who believe that climate change is happening, and that it is a result of their own actions, but decide that what they are doing is more important for achieving their own objectives.

N. https://climate.nasa.gov/resources/global-warming-vs-climate-change/es.

You only have to cross a bridge if you want to get to the other side

WE'LL CROSS THAT bridge when we come to it. It's a common phrase, a proverb. We'll deal with the situation when, and not before, it occurs. Don't look for trouble before it shows up. Don't try to solve problems that we don't have. We need to get through the territory we're in right now, and if we don't make it we won't be crossing any bridges.

There are three possibilities implied in the proverb: you never get to the place where you would need a bridge; you get to the place where you need to cross and build the bridge to get over to the other side; or, you get to the place where you would need a bridge, but you can't build the bridge that would take you over to the other side, so you don't get there. Maybe at some point in the future someone might come along with a new invention (like a hot air balloon, for example) to get you to the other side, or a natural event (like a severe drought that dries up what had been a roaring river) eliminates the need for a bridge. There is a fourth possibility that is not implied in the proverb: you decide that you don't want to cross over to the other side because you don't want what is there.

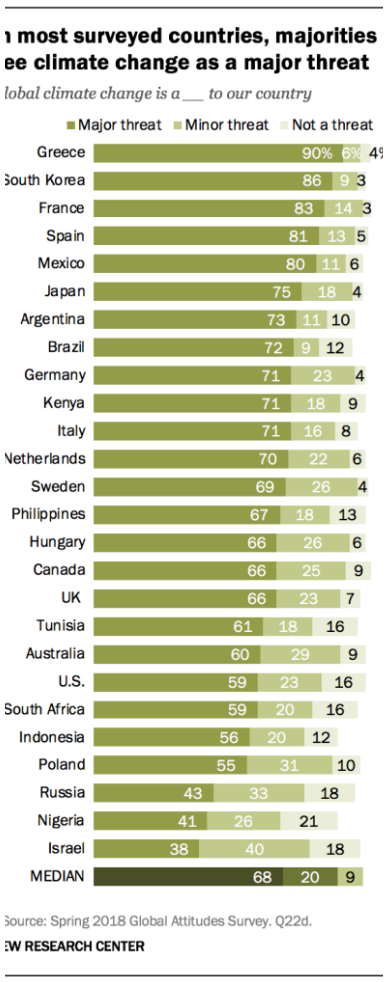
Why am I talking about crossing bridges? It is an excellent metaphor for understanding the different positions that individuals and their governments have on the issue of global warming and its resulting effect on climate change. Climate refers to the long-term regional or even global average of temperature, humidity and rainfall patterns over seasons, years or decades. Global warming is the long-term heating of Earth's climate system, observed since the period beginning in 1850 to today, due to human activities, primarily fossil fuel burning, which increases heat-trapping greenhouse gas levels in Earth's atmosphere. The term 'global warming' is frequently used interchangeably with the term 'climate change', though climate change refers to both human- and naturally-produced warming and the effects this warming has on our planet. Global warming is most commonly measured as the average increase in Earth's global surface temperature.[N]

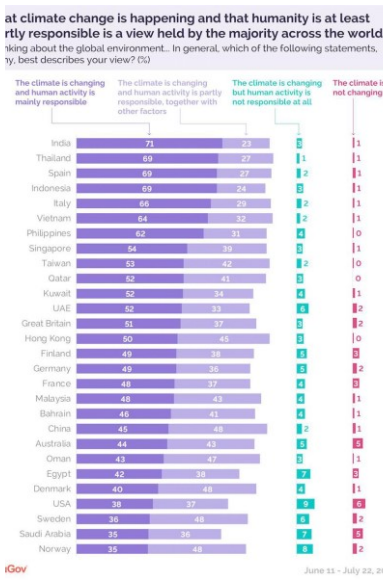
Climate change deniers don't believe there is a bridge waiting out there somewhere to be crossed and certainly not one that has to be built. In 2018, the deniers were in the majority in Russia, Nigeria and Israel according to a PEW RESEARCH survey (see sidebar – note that China is not included among survey respondents).

YOUGOV, apparently with the acceptance of the Chinese government, has managed to recruit a panel of members in China. There is no information about how these members were chosen or whether their responses are monitored by the government, but China is included in a climate change survey YOUGOV performed in July 2019 (second chart in the sidebar). In this survey, only 1% of the Chinese respondents say that the climate is not changing, and only 2% believe the change is not caused by humans, while 93% say that that it is changing and it is mainly or partly the fault of human activity. In the same survey, 6% of Americans deny that the climate is changing and 9% say if it is changing, it isn't our fault. 75% of Americans believe that it is changing and it is human activity that is at fault.

Some climate change believers and agnostics put their faith in human ingenuity and are sure we will be able to build the bridge if and when it is really needed. This is the group who view climate change as a minor threat. There was a rather large number of countries with 20-30% of their people who saw climate change in 2018 as a minor threat, even countries such as The Netherlands which has a good chance of disappearing if water levels rise as a result of melting glaciers (i.e. land ice). Maybe the Dutch believe in the fable about Hans Brinker putting his finger in the dike and saving his town.

Climate change alarmists are certain we will need a bridge, have decided on the absolute latest date when it will be needed (2050) and want everyone to basically drop everything and start working on building that bridge right now. One of them spray painted the phrase "There is a climate crisis!" all over our community, including on several perfectly innocent boulders that had been sitting there minding their own business for longer than there were Swedes. This is the group who see climate change as a major threat. In the PEW survey, fully 90% of the Greeks saw it as a major threat as did 69% of Swedes and 59% of Americans. The median was 69% who were certain it was a threat, 9% who were sure it wasn't and 20% who were unsure. Two years later, a 2020 *Yale University Climate Program* survey found that 72% of American





https://www.forbes.com/sites/jamesconca/2019/09/17/how-does-everyone-feel-about-climate-change/

adults responded 'yes' to the question: *Do you believe global warming is happening?* 12% said 'no' and 16% were unsure.[20]

The fourth group include those who believe that climate change is happening, and that it is the result of our own collective actions, but decide that what they are doing is more important for achieving their own objectives. This group includes governments, individuals, businesses and organizations. A government may have a public stance, which may or may not be supported by the majority of its citizens, but could have a completely different position that is aligned with its goals and ambitions for the country. Individuals may say they are concerned about climate change, but will work against any changes that affect their personal welfare. Members of this group do not want to build a bridge because it would mean giving up what they have on this side.

Any company, individual or organization working directly with the production and servicing of motorized vehicles, whether it is a car or truck manufacturer, car insurance company, a used car salesman or a tow truck operator, needs to be prepared for what is going to be happening in the coming decade as a result of the different paths that the United States, the EU countries and China are going to be taking on the issue of global warming and climate change. It does not matter whether governments have signed treaties like the Paris Agreement. It does not matter what country leaders are saying publicly. What matters is what they are actually doing and will continue to do in the coming years. We have heard the prelude; now it's time for the main movements.

If it's a threat, what are we afraid of?

Do a search on the question: "Why are people afraid of climate change?" and most of the answers relate to why they are predisposed to answer that there is or is not a coming day of reckoning. The answers refer to the respondents' level of education (people with higher levels of education are more frightened than people with lower levels, presumably because they believe they 'understand the science', so people who believe they are 'smart' will always say the planet is under climate attack), party affiliation (right wingers say it's a load of bunk and left wingers say it is an existential crisis), or whether they are prone to fear, anxiety or trauma.

It's difficult to find the real answer to the question that personally affects people. My city will be covered in water: I'll move. There will be more forest fires: I won't live near forests. There will be more droughts: Don't they desalinate water in Israel?

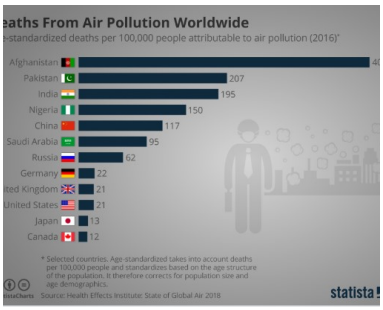
20. https://climatecommunication.yale.edu/visualizations-data/ycom-us/

I want everything to be like it was for you, but only the good parts

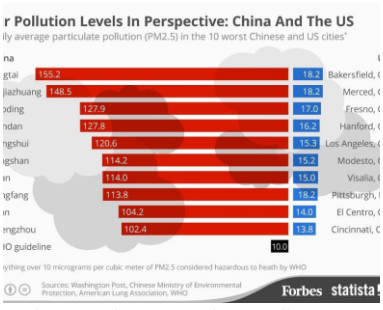
It turns out that children and young adults are worried that their lives will not be as happy and peaceful as the lives of their parents and grandparents and everyone who came before them. The fact that their parents or grandparents endured wars, depressions, droughts, famines, plagues or other types of hard times somehow is left out of their equation. The young people worry about bringing children into a hostile world, about wasting time on school and earning a degree that they will not be able to use because there will no life left on earth within their lifetimes. Skipping school to protest against everyone not dropping everything to build that bridge is considered perfectly okay by them and apparently everyone, including their parents, who allow them to get away with it.

It reminds me of some of the children I grew up with in the early 50s who were worried that Russia was going to send a nuclear missile over to our hometown and that would be the end of everything. Of course, there were children in Russia who worried about being on the other side of a nuclear missile launch as well. "What's the point of doing anything when it's all going to disappear in a great big ball of fire?" For my generation, the ball of fire was going to be caused by nuclear bombs. For this generation, it is the sun that will burn us all up.

When people in China are asked about climate change and say it is a threat, what is it that they are really thinking about? It is pollution. The reason for this is that only in India do more people die each year as a result of pollution. In China it's twenty-five times more than in the U.S. and one hundred times more than in Germany.[21] In 2007, during my first visit to China, I experienced the notorious Beijing inversion. When I returned in 2010, the air was noticeably better, and I saw significant improvements during the next five years that I was there on a regular basis. It was the *2008 SUMMER OLYMPICS* that lit a fire under the government to reduce air pollution in Beijing, principally by forcing residents to replace their coal-fired stoves which they used for cooking with gas-fired stoves. The Beijing authorities also temporarily shut down the Shougang steel works that employed 134,000 workers and emitted 10% of the particulate matter that caused Beijing's air to be among the worst in the world. In the years after the *OLYMPICS* the entire plant was moved out of the city. Another measure was to institute alternate day car operation, depending on the last digit in the license being odd or even.



21. https://www.wefo-rum.org/agenda/2019/08/china-air-pollution-blocks-solar-panels-green-energy/



Climate Change and Air Pollution in China (2016)

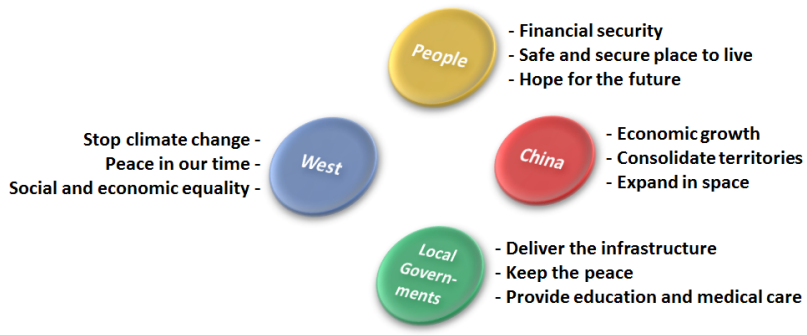
China now boasts five of the ten most polluted cities in the world. Even the tenth worst city in China is five times more polluted than the first in US.

These measures did reduce pollution in Beijing and made a significant difference in the perceived well-being of Beijing residents. It also achieved the government's principal short-term objective of making the city more enjoyable for all the foreign tourists and dignitaries attending the first *OLYMPICS* held in the People's Republic of China.

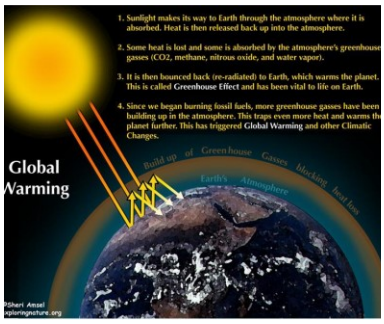
What the Chinese government did in Beijing was interpreted as "China is doing something about climate change", when in practice China did what most western countries had done fifty or one hundred years earlier, stop people in the middle of cities from burning coal to cook their food. China will continue to take similar measures to the extent it believes it will contribute to the feeling of well-being by its citizens. However, you will not see demonstrations on the streets in Shanghai, Beijing or Chongquing like those by Extinction Rebellion or the Friday school skippers in western countries. For the people of China, the world will not come to an end because they continue to burn coal to produce all the electricity their industries and homes need to be the most prosperous country in the world. It's the reverse. Their world will not continue to improve unless they do continue burning coal—as long as it's not burnt in their cities.

We see the future from different points of view

There is no question that the world's temperatures are rising. It's not because I drove my ICE car yesterday. It's because we started building steam trains and making steel and producing electricity a hundred-and-fifty years ago, and because we used coal to power all of these activities. The CO_2 we put up in the atmosphere is still there.[22] Approximately 43% of our CO_2 emissions stay in the atmosphere. The rest are absorbed by carbon sinks, including the oceans and vegetation. Yes, by driving my non-BEV car yesterday I added to it, but the coal being burned in China to power their growing fleet of electric cars added more to it in a minute than I have added so far in my lifetime.



Country, local and personal ambitions



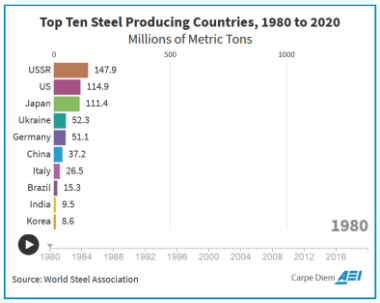
22. Scientists attribute the global warming trend observed since the mid-20th century to the human expansion of the "greenhouse effect" — warming that results when the atmosphere traps heat radiating from Earth toward space. Certain gases in the atmosphere block heat from escaping. Long-lived gases that remain semi-permanently in the atmosphere and do not respond physically or chemically to changes in temperature are described as "forcing" climate change. Gases, such as water vapor, which respond physically or chemically to changes in temperature are seen as "feedbacks." Carbon dioxide is released through natural processes such as respiration and volcano eruptions and through human activities such as deforestation, land use changes, and burning fossil fuels. Humans have increased atmospheric CO_2 concentration by 47% since the Industrial Revolution began. This is the most important long-lived "forcing" of climate change. https://climate.nasa.gov/causes/

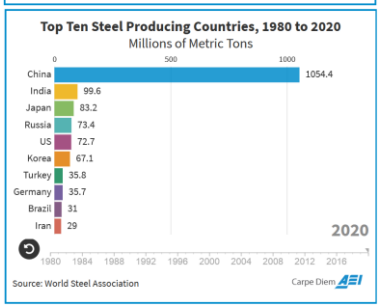
Of course China knows this. It also knows that if it stops burning coal to fire its steel furnaces and to produce the electricity it needs to power its manufacturing juggernaut it will lose its chance to pass the U.S. as the world's largest economy. It may not get another opportunity to accomplish this important goal for a very long time. Economic growth is China's main goal because it is essential for it to achieve all of its other goals, including consolidating its territories and expanding in space. Coal fuels its industry; money fuels its expansion. Money does not grow on trees. It grows in steel furnaces. (See charts in sidebar.)

The West, following the removal from office of the former PotUS and all of his climate change deniers, is once again united with its western allies, having rejoined the *Paris Agreement*. Most of the European countries, the US and Canada are committed to stopping climate change. They are focused on developing policies that will provide social and economic equality for everyone, and they are dedicated to looking for ways to achieve peace. This may be a very simplified explanation of what western democracies are doing, but I believe it covers the main policy objectives at the present time. Read the EU and U.S. 'green new deal' manifestos' and you will see that they promise economic growth as a result of making heavy investments in renewable energy sources. New jobs will be created, they say, to replace all the jobs lost as a result of closing down industries based on oil, gas and coal. They also say that those industries must disappear quickly in order to reduce the risk that global warming will increase, in spite of the fact that these industries are providing many jobs. What they hope for, <u>but cannot guarantee</u>, is that the number of replacement jobs will be able to keep up with the number of lost jobs. Economic growth is therefore not the priority; the priority is keeping Earth from becoming too hot to sustain our lives.

It's different in China. It's always been different in China

Those who are in charge in China, the Chinese Communist Party, understand that their own future is dependent on delivering continuous economic growth so that the large majority of its people who are currently not benefitting from what the country has achieved thus far will begin to see the light in their own tunnel.[23] It has done well to drastically reduce the number of its people living below its official poverty level, which is about $360 per year, but it must increase that level a hundred fold to really make a difference for its citizens on a world stage.





China produced more steel in 2020 than the next nine top producers combined. In 2020, the U.S. produced one-half of the steel that it produced in 1980.

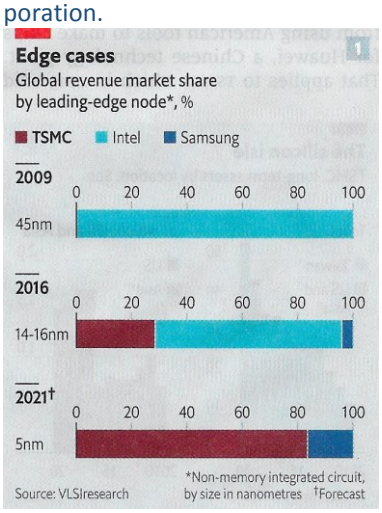
23. A joint study in 2016 by LIMRA Secure Retirement Institute and the Society of Actuaries revealed that 53% of Chinese workers are uncertain if their savings will last through their retirement years. 48% of Chinese depend on personal savings and investments for retirement. Household savings rate in China is 30%, compared to 6% in the U.S. Only about half of the country's medical and health personnel work in rural areas, where approximately three-fifths of the population resides. The doctors of Western medicine, who constitute about one-fourth of the total medical personnel, are even more concentrated in urban areas. Similarly, about two-thirds of the country's hospital beds are located in the cities.

A major part of its strategy is to unite all of the places it believes are part of historical China and to put all of their resources to use for the good of the country. As the world has seen with Hong Kong, China is determined to bring all of what it considers its possessions under the control of the government, and Taiwan is now its number one priority.[24] The fact that a company based in Taiwan, TAIWAN SEMICONDUCTOR MANUFACTURING CO., now controls the world supply of semiconductors, simply makes this more urgent. TSMC is a critical player in the current semiconductor shortage that not only affects industry outside of China, but is having enormous impacts on Chinese business.[25]

24. *THE ECONOMIST* April 3rd 2021 and *THE ECONOMIST* May 1st 2021.

China's leaders have also made dominance in space a matter of urgency. While its own Mars vehicle roams the planet's surface, perfectly timed to be there at the same time as NASA's *Perseverance*, it is building its own space station to rival the International Space Station that the West has been operating for the past twenty-two years. Just as the G7 countries completed their meeting in Geneva, China marked the event by sending up a rocket carrying their astronauts to work on their station.

25. TSMC now has more than double the market capitalization and double the share price of Intel Corporation.



People and local governments have another perspective

People the world over and local governments have different priorities. Irrespective of whether one is living in Boston, Brussels or Beijing, individuals have more mundane objectives than dominating space or corralling countries. We want financial security, a safe and secure place to live and we want to be able to believe there is a future for ourselves, our families and our friends. Local governments are expected to see to our basic everyday needs with infrastructure, education and medical care, and we expect our local governments to ensure that we are living in a safe and secure environment where everyone lives by the rule of law and if people break the law, they are punished.

The West cannot cross the bridge without China

As I said, we have heard the prelude; now it's time for the main movements. China's GDP growth was 11.5% in the quarter ending in June 2020, after having contracted (due to COVID-19) by 10% in the previous quarter. Since June of last year, it has been expanding at a rate of around 2.5% per quarter, or 10% per year, until the most recent quarter, when growth was a mere 0.6%. In other words, the COVID-19 pandemic caused a blip. The *BEIJING MOTOR SHOW* was even held in September 2020 while the rest of the world was going into its second wave of COVID-19. Like any country now or in history experiencing an economy boom driven

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by its manufacturing industry, China's economic growth has an environmental dark side, but it is the economic bright side on which the government and its citizenry are concentrating. Chinese people believe that their government is doing a great job to reduce pollution, and for them, that is the climate change that is happening. It is a blessing, not a threat. The 1% who don't believe it is changing don't feel the government is doing enough to stop pollution.[26]

Once China passes the U.S. as the world's largest economy, either in 2028 as had been predicted or in 2026 as now looks more likely due to the COVID-19 impact on the U.S. economy, it will not look back. On the 9th of June, President Biden said that China would not become the world's largest economy on his watch, and his administration are now attempting to effect changes in how U.S. businesses and governments conduct their businesses, but China is certain that it has the upper hand. It has produced the deck of cards the world is playing with (literally) and it is now in the position of dealing them out. The U.S. and the rest of the Western countries allowed that to happen because they thought by opening up to China and accepting their terms of doing business, China would become a capitalist democracy just like theirs. A dream.

China will not meet its principal goal of economic growth without burning lots and lots of coal and oil and gas. OPEC and Russia will take up all the slack left by the U.S. if the U.S. stops pumping and fracking for oil and gas as demanded by the environmental lobby. China passed the U.S. in 2017 as the world's largest importer of crude oil. In 2020, in spite of the pandemic, China's crude oil imports set a new record and were up by 7.3%. Even if the U.S. and EU ban ICE vehicles, there will be 9 billion people outside of the U.S. and Europe who will still be buying and driving them, and their countries will be the second-hand markets for the cars and trucks whose owners will no longer be able to purchase fuel for them in the West. If the jobs do not materialize as promised in the decarbonned countries, those who have lost out will use their ICE cars to drive to China to find work and a place to live. **(See sidebar)**

Having made major sacrifices to meet its commitments to the *Paris Agreement* and the promises to those who were children in the early 2020s, all the U.S. and the EU countries will have achieved is the relinquishing of power to those countries that have just kept on doing more of what they had already been doing: burning coal. Western countries will be even more dependent on the products produced in China and its client states. Some

26. https://www.forbes.com/sites/thomasduesterberg/2020/11/05/chinese-growth-and-climate-change-is-china-a-responsible-stakeholder-in-the-paris-climate-accord/

An Uncomfortable Truth

"From the earliest recorded history, up until the 17th century, all places across the world were roughly as rich as each other. The most authoritative historical GDP data is from Angus Maddison. These show that in the year 1000 the country with the highest per-person GDP (Iran and Iraq tied for first) was only about 50% righer than the world's poorest country for which there are data (Denmark, Finland, Norway, Sweden and Britain, all joint last).

"As feudalism withered, markets became stronger…and the world entered a period known to historians as 'the great divergence'. By 1900 Western Europe and America had become far, far richer than anywhere else. In that year the world's richest country, Britain, was over eight times richer as the poorest, ***China****."*

An extract from The Classical School: The Birth of Economics in 20 Enlightened Lives *by Callum Williams. The Economist Books (2020) page 4.*

western countries, like Greece, Hungary and Montenegro, may have already become part of China's sphere.[27] Russia, totally lacking an industrial base and with a population that has dwindled below 100 million while controlling a vast amount of land, will have probably leased most of its Asian land holdings to China, which will build satellite communities around mining and industrial centers, as Russia once did back in its Soviet heydays.

As it looks right now, when it's time to cross the bridge we will not be able to do it. There is no point in claiming that we have created a carbon-free environment in the U.S. and Europe while China and other countries burn coal and continue to increase global warming. We have to have a carbon-free environment everywhere. It makes no sense to naively claim we are driving emission-free vehicles when the steel and batteries and plastics and the vehicles themselves are made in China. It is just plain silly to brag about generating sustainable electricity to power those vehicles when we are using wind turbines and solar cells made in China.

The days of being a casual observer are past

No one can continue to be just a spectator. The days of countryless cosmopolitans are over. Even the super-rich will have to pull into ports to resupply their yachts and show their ID papers. Individually and collectively with our governments, we are all going to have to make choices, the main one being whether to try to cross the climate change bridge without China, as the Western countries appear to be doing, or to begin to change our mindset to ensure that China will cross the bridge with us. As you can understand from what I have written here, I do not see any possibility for a positive outcome if the West continues on the path of crossing the climate change bridge without China. What do we need to do to cross the bridge together, to make certain that China does not feel it can stay on the other side and keep everyone there with it?

- Decide which business partners we choose to work with: China has built up a huge supply chain advantage for electric car components all the way down to the raw materials for batteries. It has also fashioned itself as a consumer market for the cars. The more the world's governments push their citizens toward electric cars, the more China's influence grows. Either the West will have to stop promoting battery electric vehicles or it will have to force companies to invest in an alternative supply chain to compete with China's. TESLA's trying to have it both ways, and it is clear that the Chinese government is having nothing to do with it. Having lured it in with promises of independence—TESLA was the first car OEM that was allowed to manufacture in China

27. Since the 2009 financial crisis, **Greece** and China have deepened their links. In 2016, Athens has signed a €368.5 million deal to sell the operator of Piraeus port to the Chinese shipping group COSCO. This was the second major privatization for the country. The sale of Piraeus was part of Greek creditors' demands to secure a third €86 billion bailout package. COSCO was the only bidder. Greece formally joined China's Belt and Road Initiative (BRI) following the sale of Piraeus to China's COSCO.
Victor Urban's government of **Hungary** agreed with China to Shanghai-based Fudan University to open a Chinese university campus in Budapest. This would make it the first Chinese university campus in the European Union. Hungary has agreed to foot 20% of the $1.8 billion it will take to build it. The rest is coming from a loan from a Chinese bank. "The university's charter requires that it represent the world view of the Chinese Communist Party," said Budapest Mayor Gergely Karascsony, who is not at all pleased that this institution is being insinuated in his city—especially since the city was not consulted. He is not alone. Protestors have proposed to the city that it rename the streets bordering the site with names that have caused a furor in Beijing. Use your imagination.
Montenegro, a country of 621,000 on the eastern side of the Adriatic Sea, and which has applied for membership to the EU, now finds itself in the iron grip of China. It took a loan from China of a $1 billion to build a road from its deep port in Bar near its border to Kosovo to its capital, Podgorica. The idea was that the road would eventually extend to Belgrade. After 41 kilometers, the money, spent mostly to pay Chinese companies and their Chinese employees, ran out. Montenegro now has a useless piece of highway that cannot generate the tolls that were going to be used to pay back the loan, and a very large loan to a Chinese bank. When this loan is called in, as similar loans around the world to Chinese banks have been called in on countries that have no way to pay them, it is highly likely that China will get Bar.

without forming a JV—it is now making life difficult for TESLA. But Musk has made his decision. SPACEX will provide his bridge, and Mars awaits.

- Decide which products we purchase: In February of this year, President Joe Biden ordered a review of critical supply chains, and required all executive agencies to report back to him within 100 days on the risks to U.S. access to critical goods, including pharmaceuticals, rare earth minerals and semiconductors.[28] The aim was to determine how the U.S. could build up competitiveness in the face of economic challenges posed by the world's second largest economy. "Obviously, a number of Chinese industrial policies have contributed to vulnerable U.S. supply chains," a U.S. official said. "I think you are going to see this strike force focusing on feeding into some of our China policy developments…We're not going to build everything here at home. But we do have to see more domestic manufacturing capability for key products." The U.S. will be making a special effort to stop domestic companies from exporting production to China and then selling products in the U.S. You will start to look inside that baseball cap you are about to buy to see where it was made. If 'Made in China' is still on every label within the next few years, as it is today, then we had better start planning for life without a bridge and with China deciding what we do when the water starts rising.
- Make better choices about the votes we cast in local and national elections: There don't appear to be any countries in the West where politicians running for national offices are actually talking with the people they are supposed to be representing on the issue of climate change. The debate they engage in has been defined by the media, and the media outlets decide what they say and write by who they believe are their readers as well as by who is buying their influence (i.e., advertisers). They are either climate change deniers or believers, and if they are the latter they see the only solution as forcing everyone to buy BEVs and their job as lobbying for the building of charging stations. Get elected, wear the right baseball cap and don't get caught having a friendly drink with the enemy. Unless people start electing politicians who understand what is needed to build the right kind of bridge, and who understand that China must cross it as well, the world we will be handing over to our children and grandchildren will be neither clean nor democratic.
- Consider carefully what we say to our children and grandchildren: It seems we have not been talking to our children and grandchildren about something that has been very important in the West for the past two hundred and fifty years: DEMOC-

28. https://www.autonews.com/manufacturing/biden-administration-sets-strike-force-go-after-china-trade?utm_source=daily&utm_medium=email&utm_campaign=20210608&utm_content=article4-headline

RACY.[29] In a 2017 PEW RESEARCH, young adults (18-29) in Western countries are more likely than older people to prefer technocracy to democracy. The study found that in the U.S., 46% of them would prefer to be governed by experts rather than people who are elected democratically compared with 36% of respondents aged 50 and older (still high). In a HARVARD study, 25% of young adults agreed with the statement: "Choosing leaders through free elections is unimportant." In 2017, the 'former guy' was the PotUS, and another study found that fully 63% of young adults disapproved of the way he was doing his job, with 46% disapproving ***strongly***. Maybe the attitude is if that's what democracy is giving us, we don't want it. But then there was another election. The good guy won. We are not being clear and honest with the next generation of leaders. We are not helping them connect the dots between where the shoes are made that they are buying over the Internet in triplicate, how they are arriving at their door and where the money is coming to finance the entire transaction.

29. https://www.nbcnews.com/think/opinion/democracy-essential-millennials-increasingly-aren-t-sure-should-concern-us-ncna847476

On the 11th of June, the heads of state of the Group of Seven (G7) countries met in St. Ives, Cornwall, England, UK for the start of their three-day summit. For the first time in four years, it was civil and non-contentious, and the U.S. resumed its position as the leader of the major democratic powers. The U.S., Canada, UK, France, Germany, Italy and Japan, along with two representatives of the EU, discussed the major concerns facing all of the world's citizens today: the pandemic and its social and economic consequences; how to address global warming; and how to maintain peace. China was not there, but its presence was felt. The leaders sitting around the table understood full well that China is using its economic prowess to try to move the world into its sphere, just as the U.S. did and almost succeeded. The U.S. gave away to China the keys to the crown jewels and now it is finding it very difficult to recover them.

What these leaders did not do was to connect China's economic growth to the growth in global warming. If anyone at the table should understand this it is the one who has been there the longest and who will not be there when they meet again next year: Angela Merkel. The Berlin Wall did not fall for political reasons. It fell because the Soviet Union could not keep up with the West in defense spending. It's different now. It's China that has the money and it can use it to outspend the West anywhere and on anything. But it's the West that is sending over the money to China by the boatload, filling all those containers that arrived with all the products the West consumes. China will not stop burning coal until it doesn't need to do so, and it won't need to stop until it doesn't have to produce steel and cars and batteries and baseball caps and just about everything else for the rest of the world.

About Michael L. Sena

Michael Sena, through his writing, speaking and client work, attempts to bring clarity to an often opaque world of highly automated and connected vehicles. He has not just studied the technologies and analyzed the services. He has developed and implemented them. He has shaped visions and followed through to delivering them. What drives him—why he does what he does—is his desire to move the industry forward: to see accident statistics fall because of safety improvements related to advanced driver assistance systems; to see congestion on all roads reduced because of better traffic information and improved route selection; to see global emissions from transport eliminated because of designing the most fuel efficient vehicles.

This newsletter touches on the principal themes of the industry, highlighting what, how and why developments are occurring so that you can develop your own strategies for the future.

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