

# Learning to share

We last published an article by **Bern Grush** in *Thinking Highways* in which he repented spending so many years dedicated to road user charging without recognizing what he finally came to see as immovable, socio-biological reasons for most motorists to be unwilling to leave their personal vehicles for bus or bike. He now joins **John Niles** to explore whether it will be possible to move these same stubborn motorists from personally owned vehicles to shared vehicles in massive numbers. They both seem more optimistic this time, as **Louise Smyth** discovered, but how does that relate to tolling?

**Tolling Review:** We've been reading a steady stream of optimistic reports and comments about the driverless vehicle, and of course there are detractors, but you two seem to both optimistic and concerned at the same time. If the autonomous vehicle (AV) will be safer, cleaner, reduce congestion and give us more time to work or relax, what do you see as the downside?

**Bern Grush:** You're right that we believe the self-driving car will be good in all those ways. But we also know that throughout history, having too much of a good thing — or to be overly successful — has almost always led to new, unintended consequences. Agriculture led to cities and global warming, sanitation led to dramatic population growth, the assembly line led to automotive congestion. Big technologies lead to massive effects and the autonomous vehicle is clearly a big technology.

**TR:** ...but this time the effects look pretty good...

**John Niles:** Not all of them. Besides the manageable labor displacement during the settling in period, we really have to worry about environmental costs. If the average AV embeds about half the manufacturing footprint of today's car, but we make four times as many of them...

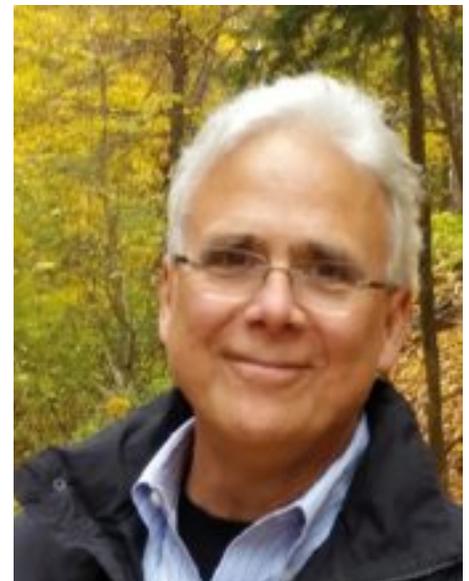
**TR:** four times as many?

**JN:** Well, the current doubling time for the vehicle population is 17–20 years so all things being equal, we can expect



Is it sensible to believe that drivers will give up their car keys and rely on transportation services from autonomous vehicle fleets?

**“Big technologies lead to massive effects and the autonomous vehicle is clearly a big technology”**



Bern Grush

## “The real estate and infrastructure value of parking spaces in the United States, today far exceeds the value of all the operational vehicles in the US”



John Niles

by 2050 to pass four billion vehicles, up from just over a billion currently.

**TR:** But that is worldwide. Surely the vehicle count in Britain or the US won't quadruple! Are you ignoring all the evidence for declining vehicle ownership and the number of younger drivers turning away from driving? Won't a majority of hard-core drivers be gone by 2050?

**BG:** Well, there's a lot to that question. First of all, we are very much interested in the worldwide picture — especially from a climate perspective. And of course you're right that there are trends toward less automobile use among some population segments. We think some of that is in rebound due to economic recovery, and as you know, the trends are in the opposite direction in countries such as China and India. But our point is that even in car-saturated populations such as in our three countries, we fear that the

AV would re-ignite demand for personal automotive travel with a vengeance. The automobile provides an overwhelming number of benefits on a majority of trips for a majority of people. If automobility becomes so much better and so much more accessible it will be demanded more. One can imagine the possibility of the current per-capita ownership in the US moving from 0.81 to 1.1. Of course the larger concern is that the current ratio in China could climb from 0.2 to 0.7 or in India from 0.04 to 0.5<sup>1</sup>.

**TR:** But those kinds of increases are already predicted — at least for Asia...

**JN:** Exactly. Many projections say that. And that leads to incredible infrastructure demands and energy and material demands—all with large carbon footprints.

**TR:** So what do you propose?

**BG:** We are proposing policies and actions to nudge travelers toward ways of satisfying their demand for person miles traveled (PMT) in motorized vehicles without increasing the operational vehicle population. We are taking the projection of a quadrupled vehicle population growth to imply that the VMT (vehicle miles traveled) and PMT would also quadruple as an approximation. In fact, our work is based on the assumption that PMT demand is the causative factor and that VMT and vehicle population levels are the results of low vehicle occupancies and high ownership preferences, respectively. We assert that it is possible to provide a four-fold PMT with the same number of vehicles that are currently operating.

<sup>1</sup> [http://en.wikipedia.org/wiki/List\\_of\\_countries\\_by\\_vehicles\\_per\\_capita](http://en.wikipedia.org/wiki/List_of_countries_by_vehicles_per_capita)

<sup>2</sup> <http://www.planbeconomics.com/2014/11/continental-cfo-driverless-cars-by-2025.html> (start at 4:00 to listen to Continental CFO Wolfgang Schaefer discuss auto units)

**TR:** Sounds like Alice in Wonderland — we'd be running fast just to stay in the same place. And we'd still have four times the VMT.

**BG:** Yes, but we need to look at the whole system. First of all, the embodied carbon emissions in today's motor vehicle are equivalent to the carbon released in approximately its first 100,000 miles. Since the manufacture of AVs will generate an emissions profile, we have a GHG issue just from the volume of vehicles made quite apart from any operational considerations. So, more PMT with the same vehicle count will always be smarter. And these are just the first order effects. The real estate and infrastructure value of parking spaces in the United States, today — the cost of all the infrastructure, spots, pavement, lots, garages and driveways — far exceeds the value of all the operational vehicles in the US. That is well documented in Donald Shoup's *The High Cost of Free Parking*. The carbon cost of parking is astonishing and seldom considered. So having fewer vehicles, each averaging four times more PMT and perhaps only 3½ times as much VMT would...

**TR:** Why that difference?

**JN:** That's easy. We get more PMT per vehicle with car sharing, which we call *serial* sharing. After I am done using a car, you have a turn. We also get more PMT per VMT with ride sharing that we call *parallel* sharing in which people, usually strangers who would not normally share a vehicle, do so. By the way, in our scheme, 16 people on a bus (not counting the driver) are ride sharing, but mom

driving her child to karate class is not. We do not count the chauffeur, because the AV does not have one. In our calculations the chauffeur is necessarily part of the vehicle. However, if you and I share a taxi from the airport, that's ride sharing.

**TR:** In other words, you are proposing a lot of serial sharing but relatively little parallel sharing?

**BG:** Right...lots more serial than parallel sharing.

**TR:** Why is that?

**JN:** We see many barriers. Three things come to mind that make parallel sharing less appealing than serial sharing: time, convenience and personal privacy. Time and convenience — related to waiting or going out of our way — compare poorly with a vehicle dedicated to just you and your trip. That is already a key reason for the SOV. The privacy aspect is critically important to many people in many cultures and there are gender, class and health aspects. We are simply recognizing these exist and respecting them in our thinking. Without prejudging anything we observe that there are many more barriers to ride sharing. In a study I did two decades ago, I found 16 barriers, including personal safety concerns, interpersonal relationship issues, and opinions about the maintenance of the vehicle.

**TR:** A lot of people seem to think that car sharing will mean very many fewer vehicles, but I recently heard Wolfgang Schaefer, CFO of Continental say<sup>2</sup> that at best car sharing means cars will wear out more quickly so that the same number or greater number of cars will still be manufactured. So where do you think the benefits will really come from?

**BG:** Of course shared vehicles will wear out faster, depending on their duty cycle. To date, car sharing has been shown to decrease car ownership and VMT. However, those figures are likely skewed because today's car sharers are multimodal



With this form of ride sharing, the driver of the bus is not an actual traveler; with autonomous buses all passengers are actual travellers

city-dwellers on the margins of the car-user profile. If you look at the Larry Burns robo-taxi model<sup>3</sup> — he calls them shared, driverless vehicles — you see a self-managed fleet of CATES vehicles that can have a Robotaxi to you within 2 minutes in almost all circumstances. The likelihood of a person switching from ownership to serial sharing would be much higher if a vehicle can be reliably provided as quickly as you can back your car out of your driveway. Such a massive adoption, coupled with frequent use because it is so cheap, will make Schaefer right.

**TR:** Before we go any further, CATES is an acronym I have not heard before. What is it?

**JN:** Larry Burns frequently points out that to extract full societal value from the future car it will be critical for it to be autonomous, connected, electric, shared and tailored. By tailored he means sized and configured for the purpose at hand. We just reordered his list to make it pronounceable. CATES means connected,

autonomous, tailored, electric and shared. A CATES urban fleet would have a preponderance of one- or two-passenger vehicles for commuting or routine shopping trips. And of course a few vans, SUVs and pickups as well as autonomous buses and shuttles. Regional fleet make up would be tailored for the population it serves. Relative portions of smaller or larger vehicles would differ between dense cities and rural areas. In fact, the portion of shared PMT vs non-shared PMT would differ, as well. In the best of all possible worlds, the optimal proportions would float based on local demand rather than government planning. This would be aided by the rapid turnover of shared fleets, which might be, say, two to four years instead of 12 to 20.

**BG:** These five things are all critical. We assume that competing armies of engineers will continue working at the autonomous, connected, and electric aspects. But for our four-times-the-PMT program to work, it is really Burns' notions of tailored and shared that are our focus. Tailored makes them cheaper and the fleet optimizable in ways not possible

<sup>3</sup> Larry Burns, *Transforming Personal Mobility*, Columbia Earth Institute, January 2013 (revised)

## “I used Uber recently where the driver showed up in a massive SUV where a Smart ForTwo would have sufficed. And of course they are far from autonomous”

with today’s mix of vehicles. Shared means serial sharing or Robotaxi – like an Uber vehicle almost always arriving in under two minutes, but always without a driver and usually only just big enough and powerful enough to zip you and your what you’re carrying to your destination. Shared also means parallel sharing such as shuttles, buses or jitneys.

**TR:** Since you use Uber in an analogy, can I guess that this service is a role model for your thinking?

**BG:** It is, but only from the perspective of mobility as a service. Uber is *connected* only in a very minor way since it is controlled by a smart app that is mediated by two humans in concert. Neither of us has been in an *electric* vehicle from an Uber call. They are *shared* in the sense that there was another passenger before me. They are certainly not *tailored*. I used Uber recently where the driver showed up in a massive SUV where a Smart ForTwo would have sufficed. And of course they are far from *autonomous*.

**TR:** So will anyone own his or her personal vehicle in your vision?

**JN:** Certainly. We would never propose a situation where no one could have a personal vehicle. All we really need to have is most of the total fleet ready to be shared with a smaller portion reserved for private access. Consider that currently the average private vehicle in North America is only being used 5 per cent of the time. A fleet being used an average of 20–25 per cent of the time would easily manage four times the PMT.

**TR:** How realistic is that?

**BG:** To get to a much more intense duty cycle we are proposing a split among a variety of vehicles tailored to different purposes and deployment loads. As a very simple illustration, imagine the entire world fleet in three segments: a quarter privately owned or somehow dedicated to a single unshared purpose (such as a fully outfitted service vehicle for a plumber) and are in mobile service only 5 per cent of the time as now;

another quarter shared but so specialized as to be clicked on relatively infrequently, such as luxury vehicles or outsized vans and so would be in service only 10 per cent of the time; and finally the remaining half tailored for frequent service (such as commuting and shopping) and in service a third of the time. Such a fleet could easily provide four times the PMT provided now. But this simple example implies 80–95 per cent of the trips worldwide would be in such shared vehicles — a far cry from today.

**JN:** Of course, such an ideal fleet would need to be perfectly distributed and have the same average roadworthiness as now. With the average shared vehicle expected to be busy just under a third of the time, there should be plenty of time for fueling, maintaining cleaning and redistributing. We think organizing a future world of autonomous vehicles this way is tractable, but that most of us would balk, at first.

**TR:** That’s certainly true – I know a lot of people who really prefer their own vehicle. It is a very personal space for many if not most of us. Around 90 per cent of trips in what are essentially taxis, buses or rental vehicles will sound off-putting to many.

**BG:** We agree, hence our work. What portion of preferring your own vehicle is habit? What portion is the matter of personal space — privacy really? What portion is control over when and how you get there? What portion is that your vehicle advertises your level of achievement or enhances your personal attractiveness?

**JN:** Mobility as a service can easily enhance some of these things, but not others — or at least not apparently. Our question is what things could be done to nudge travelers to shift their revealed preferences from using a personally owned vehicle to any of a variety



Our reliance on personal vehicles could be reduced with five or ten minute smartphone access to the perfect, self-arriving vehicle for every sort of occasion

## “People are much more likely to accept tolling on a new highway segment or bridge, and much less so as an outright replacement for fuel taxes as an “everywhere” road use charge”

of shared vehicle options so as to have a great majority of all trips take place using shared vehicles? We think we know how to do that, but it will take many thoughtful nudges from governments and programs from NGOs, companies, communities and civic institutions.

**TR:** Can you give me any examples?

**BG:** Sure, there are many reforms that could promote sharing now. Insurance innovation and taxi reform are important — see all the concern around both Uber and Lyft. Things like parking reform and HOV or HOT lanes can be key since demand-based pricing can encourage sharing. We have identified over 80 approaches so far that can be started now to create the transportation ecology we need — one with a revealed preference for PMT in shared vehicles.

**TR:** But how does all this relate to tolling?

**JN:** Well, first it’s important to distinguish the two purposes for tolling: demand

management and infrastructure funding. It also has two policy approaches: tolling of limited access highways mostly to fund infrastructure and second, road use charging (RUC) as contemplated to replace fuel taxes. While there is considerable overlap in the arguments for each of these policies, the acceptability of the two forms of charging is very different, and they can get muddled and cross-contaminated to a degree. People are much more likely to accept tolling on a new highway segment or bridge, and much less so as an outright replacement for fuel taxes as an “everywhere” road use charge.

**TR:** So how does sharing autonomous vehicles help?

**BG:** It helps for two reasons. As autonomous vehicles become the predominant people mover, road use charges would be sensibly be buried in the vehicle use fees removing all the various fuel-type tax arguments. The second barrier to RUC is the expense of metering the charge in a way that is equitable, reflects demand

and respects privacy. Since autonomous vehicles must be connected for fleet management and passenger security reasons, the data needed to meter and charge according to these sophisticated policies would be in place. Arguments surrounding fuel taxes and privacy would all be re-bundled into pricing for fleet users and perhaps into marginal pricing for transportation equity. In other words, all the unacceptable RUC solutions proposed will all be replaced with more tractable versions of themselves. Focusing now on any RUC ideas of a few years ago is going to where the puck has already missed the net.

**TR:** But there is still an urgency for road use charging...

**BG:** Well, judging from the tortured history of RUC, the autonomous vehicle will get there first. Transportation politicians worried about the EV eating away at the fuel tax base should switch their attention to tax policy for the autonomous vehicle...

**JN:** ...and then making sure they’re electric, at the same time.

**TR:** Well, you are certainly expecting a lot more to change over the next 30 years beyond just being able to watch TV while driving! Thank you both! 🙏



The CityMobil 2 prototype is a fully electric and driverless minibus that can carry up to 10 passengers and reach a top speed of 40 Km per hour, seen here in the city of León, Spain



**Bern Grush and John Niles** have focused on RUC and EV technologies and policies, respectively for a combined 40 years, and are writing a book *The End of Driving*

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