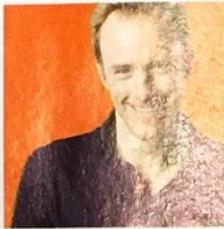


WELCOME.

The Tesla effect



'OUR ELECTRIC CAR will have to be the most exciting electric car ever launched.' It was a brief but emphatic look to the future from McLaren Automotive chief Mike Flewitt, as he presented the start-up's latest financials. As hacks swarmed around him afterwards, the talk was not of McLaren's third year of profitability or its bid to double sales in 2016, but all about McLaren's EV ambitions.

The all-electric McLaren will be realised beyond 2022, but a battery-powered 12C mule will start the quest to replicate the noise, vibrations and feel of today's supercars. The challenge is to make an electric car with the power density of the twin-turbo V8, plus a 300-mile range – today's tech cannot do that, says Flewitt.

Tesla's Elon Musk would no doubt protest that the electric Model S P90D Ludicrous can go 0-60mph in 2.8sec, and claims 316 miles from a charge. Not that you can drive flat-out for long without compromising that range, and a P90D's weight and agility are not in the supercar league. Regardless, Tesla has unleashed the potential of the electric car. Until the Model S arrived in 2012, electric car equalled city runabout. Musk had the vision to create an electric limousine, with the chassis space and price point to allow battery cells and motors with unprecedented performance.

With the Model S, the new Model X SUV and the glass ceiling-smashing launch of the compact Model 3 (more pre-orders in a week than global EV sales in a year), Tesla has kicked off the real age of electric motoring. That's why this month's *CAR* takes you inside the firm's production base, and talks to the man with a big task: to bring the Model 3 into production on time, quadrupling the company's volumes by 2020.

We wanted to put you inside a Tesla too, so Ben Miller took a Model X road trip around Texas. Critically, given the recent

death of a Tesla driver using the Autopilot function, Ben spent a lot of time using the car's autonomous capabilities: read his reflections on p68. With autonomy and electrification, Elon Musk remains at the forefront of two profound changes reshaping the car world.

'Hopefully in 2020, global EVs will be at least a few million a year,' Musk has told *CAR*. 'We want to be past half a million, [and] there'll be increased activity by the car makers. Tesla's mission is to accelerate the advent of sustainable transport. I think the industry will go fully electric, whether Tesla was here or not. We will be measured by what degree we accelerate that transition.'

Tesla rivals from Jaguar, Audi, Porsche and Mercedes will roll out soon, the electric car's desirability proven, their competitive instincts burning. 'Twenty to 30 years from now we'll all be driving electric cars, that's the endgame.' Not the words of Elon Musk but Mike Flewitt: he's making sure McLaren won't be left standing in the electric car race.

PHIL McNAMARA
Editor

↓
Tesla's Model X: cutting a swathe through conventional thinking and, with us at the wheel, cutting a swathe through Texas



TESLA: WE TOLD YOU SO

SUMMER 2010...

'Could one of these new Californian carmakers go supernova, Google-style, and become the next Toyota?' *CAR* asked that question six years ago, in the summer of 2010, when we went to Silicon Valley to drive Tesla's first car: the Roadster. Ben Oliver went for a spin with chief designer Franz von Holzhausen in the Model S concept, and asked him why he joined Tesla. 'To be in at the start is the opportunity of a lifetime. If I'd passed, five years from now I'd be kicking myself for not having the cojones to do it.' Well, quite.

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As the Tesla Factory gears up to meet demand, this is the methodology it'll clone: the Model X advanced body production line. Some 580 robots bring the uncomplaining muscle and the tireless accuracy



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TESLA

INSIDE THE PHENOMENON



In 2008 Tesla Motors was building leftfield electric sports cars and telling anyone who'd listen that it planned to kill off the combustion engine. Now it's pulled off the most successful new car launch in history, the mainstream has stopped laughing

Words Ben Miller | Photography Robert Kerian

TEXAN RUSS BURGER was like you and me. 'I'm a car guy; I drove BMWs. My first car was a Lotus Elan [the proper one].'

Then in 2013 Burger bought a Tesla. 'A P85 Model S. It's ruined me – why would I go back to a car that runs on gasoline? For oil spots all over my garage floor? To be ripped off every year on servicing? For something noisier and slower?'

Burger was an early adopter, taking delivery of his Model S less than a year after the car went on sale. (Tesla's first car was an electric roadster built by Lotus around a lightweight aluminium chassis). The Model X SUV, launched last year, is not for him – 'Too big; I don't need the space.' But he has two Model 3s on order and is evangelical about Tesla, the cars it makes and the way in which it goes about its business.

But Tesla is not content with 80,000 cars a year and a happy clique of enthusiast owners. CEO Elon Musk (see panel, right) has said time and again that the objective is nothing less than the 'transitioning of the world to sustainable transport'. Or the banishment to history of the filthy combustion-engined car.

'That really is the endgame – a pure motivation for us,' says president of global sales and service Jon McNeill with conviction. 'The total global car market is 90 million units. Last year we sold 50,000 cars, so we have a long way to go, but that's what drove the founders, Elon and JB [Jeffrey Brian Straubel] to start thinking about electric cars in a world where we weren't including the impact [of combustion cars] on the environment and on ourselves. You've seen the statistics: whether you look at North America, Europe or Asia, more people – almost twice as many – die of auto emissions-related cancer each year than will die in a fatal traffic accident.'

'We want to be past half a million units,' says Musk. 'Then there'll be increased activity by the carmakers. Tesla's mission is to accelerate the advent of sustainable transport. The fundamental of Tesla will be measured by what degree we accelerate that transition.'

In its short history Tesla's already confounded market analysts, established itself as the automotive Apple, ruffled carmakers' feathers, built its own global fast-charging infrastructure for long-distance EV travel, opened a monolithic battery factory, raced to market with semi-autonomous capability and built a seven-seat saloon that'll go 0-60mph in 2.8 seconds. And it's the Tesla Factory in San Francisco's Bay Area that will dictate where the story goes next. ▶



Elon Musk: big thinker

A billionaire with an imagination nearly as big as his bank balance, Musk was a co-founder of PayPal.

Silicon Valley's Henry Ford, Musk became Tesla CEO in 2008, four years after he joined. He's since masterminded its rapid expansion.

Other interests include Space X, Musk's space transportation company, and solar energy company SolarCity, which is now being integrated with Tesla to create the energy powerhouse required to deliver Musk's vision of a world powered by sustainable sources.



Inside the machine that makes the machines



Welcome to the future, if you can find somewhere to park – in total Tesla employs 15,000 people worldwide, and judging by the car park most of them work here at Fremont. Tesla HQ in Palo Alto is a half-hour drive away.



Model S bodies await motors, batteries and just about everything else. The factory operates in a state of flux as its hardware is upgraded to meet Tesla's lofty productivity targets. Extensive use of aluminium has made the company something of a master in the material

THE CAR PARK is vast and it is full. In fierce heat, under another flawless Californian sky, you climb steps, pass clusters of the kind of picture-perfect employees that architects use in concept renderings, and enter reception. There's a desk staffed by two bored looking girls but, as befits an aggressively progressive company keen to remove human error, at the Tesla Factory you sign-in on a computer: the impersonal touch.

Step inside and what you see is at once all that you expected – gleaming state-of-the-art production lines animated in choreographed autonomy – and surprising, for while great swathes of this factory space are technocratic, robotic and kept free of squishy, flawed *homo sapiens*, the Tesla Factory also hums with people, music and even humour. In one corner a Darwinian line of petrol pumps runs from museum piece, through the 20th century to a gleaming, gasoline-free Tesla Supercharger. For every unmanned parts-bearing AGV (Automated Guided Vehicle) buzzing about the place there's a smiling face beneath a baseball cap in a forklift truck, or a golf cart bearing enraptured owners on a guided tour. There are pot plants, demarcated bicycle parks stuffed like a Beijing pavement and impact-absorbing foam cladding on every stout upright and pillar. The soft drinks are free.

Originally opened in 1984, the car plant formerly known as NUMMI – New United Motor vehicle Manufacturing Incorporated – was a joint venture between Toyota and General

Motors. Located in the Bay Area, 40 minutes from Downtown San Francisco and less than ten miles from Tesla's Palo Alto headquarters, the plant assembled nearly 500,000 cars a year at its peak. Then came the global recession. In 2010 Tesla, savvy as ever, bought the place and a vast inventory of manufacturing equipment and tooling for a snip (\$42m for a plant reckoned to be worth some \$1.2bn). Limited production began in 2011, and by summer 2012 the Model S saloon was being built at a rate of 20 cars a week. In 2015 Tesla built 50,000 cars. It's on course for 90,000 units in 2016. By the end of 2018 it must build 500,000 units annually.

Any trace of the sad, silent bust of 2010 is gone, eradicated by enormous investment, lab-quality lighting, a constellation of skylights and, on almost every surface, gleaming white paint. It's been a long time since car factories were grimy cathedrals of sweat and grease and the Tesla factory's clinical and cavernous interior is a welcome refuge from the hot, bright Californian day outside. In the air-conditioned cool there is only light, whiteness and, splashed here and there to highlight the countless industrial robots doing the heavy lifting, Tesla red. The spending, clearly, has been monumental. The new paint shop, which naturally exceeds California's notoriously strict air standards, can paint 10,000 cars a week, more than Tesla currently makes in a month. The CMM (Coordinate Measuring Machine) facility gleams with nanometric precision: workers wear thermal gloves lest the heat of their bodies expand the metals they handle, and the area sits on its own foundations to ensure measurements aren't sullied by tremors, either natural or generated elsewhere in the plant.

With 500,000 square metres of internal floor space on an otherwise lightly used two square kilometre site, space is not an issue. Wander around and it's easy to see the potential for expansion. Great swathes of real estate are either idle or given over to the kind of stuff that simply doesn't belong in a manufacturing facility: parts storage, the research and development team's engineering skunkworks (cutely dubbed Area 51 by Tesla employees) and low-speed crash testing and are all currently on site. Shortly they'll move elsewhere, freeing up room for manufacturing, with parts and supplies arriving on a just-in-time basis. Parts that aren't made on-site that is, and with Tesla there aren't many of those...

Musk is evangelical on the benefits of this everything in-house, vertically-integrated approach, so much so that when he couldn't lay his hands on a suitable rocket vehicle for Space X, his space transportation business, he decided it'd be easier to design and build his own. Most car factories would be more accurately described as assembly facilities – at Fremont the only bought-in parts are those it makes no sense to tackle, like fluid pumps and brakes. Tesla claims it's the most vertically integrated car company in existence, even assembling its lithium ion batteries from individual cells, and when you see miles of copper wire ready to be mechanically wound onto motor stators on site (early Roadster motors were hand-wound, leading to subtle differences in performance between cars, like the hand-ported race engines of the past) and buckets of plastic pellets ready for moulding, you can believe it.

'Historically we've been blessed with demand that exceeds production – we've been production-constrained – and that's one of the reasons we vertically integrate, to increase the pace of production faster than we'd be able to otherwise,' says ▶

Body panels, batteries, motors, seats – they're all made on site in one of the most vertically integrated car plants on the planet. On the Model 3 some of the aluminium will be subbed for cheaper steel parts

Just as Tesla's semi-autonomous driver assist system is keen to remove human error from driving, no screens keep employees from getting in the way. Tesla palette, if you hadn't guessed, is red and white

A sea of drive units awaits its fitment. These comprise an AC electric motor, an inverter and the single-speed reduction gearbox. Rear-drive Teslas use a single drive unit; dual motors bring all-wheel drive

A Model X awaits its battery (comprising more than 7000 cells), which is lifted into place before being covered by a stout protective plate. Low weight distribution contributes to stellar safety ratings



Note fiendishly complex falcon-wing rear doors under construction. Parking lot is full of cars worth a fraction of those employees help build inside, but hasn't that always been the case?



A heat cycle towards the end of assembly cures body adhesive, anneals the aluminium and bakes the paint. Light tunnel allows for accurate inspection of the final finish

McNeill. 'It helps us scale our operations quickly, and there's a real advantage in the flexibility it gives us to be able to respond and to make improvements in a short timeframe. Tesla runs to its own cadence and it's a fast cadence. It's hard for traditional suppliers to move at that pace: being vertically integrated gives us speed and agility. It also means we can demand a really high quality threshold from ourselves.'

That quest for premium teutonic quality is clear to see at every stage of the process that takes the cars' aluminium bodies from press to paint. Parts hot off the enormous Schuler press, the largest in North America, are laser-aligned and optically scanned, as well as being inspected by eye under the nowhere-to-hide glare of fluorescent bulbs. Bodies are checked and re-checked, with remedial work being done by hand, particularly in areas too awkward for robot arms.

Aluminium is key to Tesla's transformative, disruptive modus operandi: desirable, premium and high-performance EVs that turn established electric vehicle dogma – modest performance and range for a low retail price – on its head. Crank up the list price, Tesla has shown, and the more ambitious engineering that facilitates will turn heads and open chequebooks. More compatible with mass production than the part-carbon-fibre approach BMW has adopted for the i3 and i8, aluminium goes some way towards mitigating the weight of the cars' heavy, bulky batteries. Tesla claims its cars are 30% lighter than they would be in steel, and that it's the only producer of aluminium monocoques in North America (the much-vaunted move to aluminium on Ford's F150 pick-up is on the body only – the chassis beneath remains steel).

The combination of being wedded to aluminium and crafting some pretty funky body shapes has forced Tesla to innovate, developing its own proprietary high-volume blow-forming techniques to allow for the sharp creases and deep draw in evidence on panels, like the boot of the Model X. It does things its own way in other areas too, like the friction stir welding technique it's adopted from aerospace. Developed to join two pieces of metal side-to-side with such strength you're left with no seam, the process runs a tungsten drill over the surfaces, essentially stitching the two parts together. Space X's Falcon 9 rocket uses the same technique, effectively allowing for the creation of a continuous metal cylinder. No argon or filler material is required and the finished joint is completely flush, allowing other components to be mounted flush to it without problems.

Robots take care of a lot of the welding, riveting and adhesive application, working with a speed and consistency that'd be both impossible and mind-numbing for people to match. There's a lot of adhesive in each car, glue so strong a single square inch of the stuff, once cured, could take the weight of a Model S. A final heat-treatment to the painted bodies anneals the aluminium, bakes the paint and cures the adhesive.

The more you see of Fremont, the more robots you notice. Tesla, it seems, loves robots, and most of the bigger ones now bear the names of comic book superheroes in honour of Musk's Marvel obsession. When Tesla moved in the NUMMI factory had 160 robots. Now there are 580 on the Model X advanced

body line alone. More will follow as that line is cloned to meet demand – currently it's so fast and efficient it has to be shut down periodically to allow the rest of the plant to catch up – and they're prized at Tesla for their versatility, which suits the brand's agility. Why install expensive and inflexible car lifts at \$1m a pop when two huge robots (Fanuc M-2000s, worth some \$200,000 each without 'hands') can lift the cars between upper and lower production lines, even with weighty batteries and motors installed? Tesla even customises robots: it's had the lubrication systems on some modified in order to be able to install and operate them hanging upside-down from the ceiling, saving floor space. Bat-bots, if you will.

On the way out a display of Tesla models past and present is shocking in its minimalist modesty: Roadster, Model S, Model X. That's it. They'll soon be joined by more of course – the Model 3 saloon and recently announced small SUV and truck – but it's a stark reminder of just how young Tesla is. Mercedes-Benz also tries to preserve an example of every car it has ever made but, even with hundreds of cars stuffed into a dozen secret warehouses all over Stuttgart, there are omissions. Whether Musk needs to start looking for cheap long-term storage is the great question of our age. ▶



The Gigafactory: Tesla builds its future as an energy supplier

TESLA ADMITS that its ambitions alone would snaffle the world's entire lithium ion battery production. To ease the bottleneck, and to help deliver affordable mass-market EVs with an acceptable range (Tesla says the plant will drive down the kilowatt hour costs of its batteries by 30%) it is building the Gigafactory in Nevada. The vast (3200 acres, \$5bn) plant, which has been under construction since summer 2014, was officially opened in July. That's not to say it's finished – actual completion is reckoned to come in 2020, but a modular

approach means 14% of the place is now operational, making batteries together with partner Panasonic, which has also invested in the Gigafactory. Incidentally, the official address is Electric Avenue... There are a couple of reasons for the Gigafactory, explains Jon McNeill. 'One is energy storage [Tesla recently ditched the 'Motors' part of its name, in line with its ambitions to move beyond automotive to become an energy supplier]. One of the challenges with sustainable energy is intermittency – if you have solar panels, what

do you do at night? So we've transitioned the battery technology that we continue to perfect in cars into energy storage [with the Powerwall and Powerpack]. We needed battery production for that business and we needed battery production for Model 3. Combined, they created the demand for the Gigafactory.' Together with Tesla's integration with solar equipment supplier SolarCity, Powerpack and Powerwall are key to Musk's ambition to empower individuals as their own energy supplier and to wean civilisation off fossil-fuel energy.



'We were so off with our Model 3 pre-order predictions you'd laugh if I told you the numbers' Jon McNeill



Model 3: why it's the electric car's 3-series

▶ A desirable sports saloon – sound familiar?

Like BMW's omnipresent compact saloon the Model 3, set for first deliveries next year, is an affordable (\$35,000 in the US (£26,580, but expect to pay around £30k when it goes on sale here) premium saloon measuring just over 4600mm long (4676mm for the Tesla, 4624mm for the 3-series) and able to seat five. And like the expansive 3-series range the full Model 3 line-up will run from entry-level to high performance. In established Tesla style more affordable Model 3s will employ a single e-motor powering the rear wheels. Faster variants will use twin motors for greater performance and all-wheel-drive traction. Official range will be 215 miles, facilitated at this price point by as yet undisclosed next-gen battery tech and a low-drag body. Chevrolet's \$30k Bolt, on sale in the US later this year, will have a range of 200 miles.

▶ It's mainstream but sprinkled with a little dynamic magic

The Model 3 promises to blend an awful lot of what you need – four doors, five seats, load space, comfort – with a good slug of what you want: thrilling performance and the potential to streak down a decent stretch of road. Even the lowliest Model 3 will cover the 0-60mph sprint in under six seconds and a seriously quick 'Ludicrous' upgrade has been confirmed. What's more the Model S and X have shown that a significant kerbweight doesn't have to rule out rewarding dynamics. By carrying that weight low, masking it with huge torque, fitting big wheels for a serious rubber footprint and employing proper suspension (double-wishbone up front, multi-link rear on the Model S and Model X), Tesla has already shattered the EV stigma of pathetic performance.

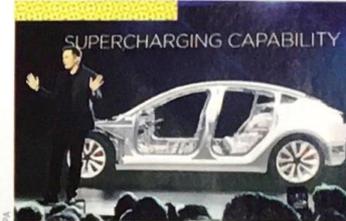
▶ It'll feel tech-heavy and expensive

Tesla embraced aluminium monocoques for the Model S and Model X, the material's potential weight advantage over cheaper steel going some way towards mitigating the mass of their vast batteries. To bring down the car's list price the Model 3's is steel with aluminium body panels. But, crazy doors aside (there are no pop-out handles or DeLorean touches here), the compromises stop there. Like its more expensive siblings Model 3 will be Supercharger compatible (for a free, 80% charge in a little over half an hour) and come with Autopilot, Tesla's impressive if controversial autonomous control system, likely to be more advanced still by the time Model 3 comes on stream.

▶ It's still a Tesla, still aspirational

Franz von Holzhausen's shape combines many of Tesla's established design cues – bluff nose, turbofan wheels, pronounced rear arch creases – with a three-box shape distorted by the Model 3's powertrain. The battery makes for a long wheelbase but with no engine up front there are short overhangs and the front bulkhead is pushed forward for a spacious cabin and generous rear-seat legroom, even for 6ft passengers. The interior's a work in progress but expect acres of glass and space, plenty of EV minimalism and a touchscreen interface to banish control clutter.

How Tesla gave the electric car its iPhone moment



When Elon Musk took to the stage on Thursday March 31 to pull the sheets from the Model 3 it wasn't the car's vital statistics or sleek-but-safe styling that blew minds. That came when Musk announced that 115,000 reservations had been taken that day. Three days later, on the Sunday, that number had more than doubled to 276,000, each with a \$1000 deposit. That's \$10 billion in implied revenue 18 months before first deliveries. Everything about the car's reveal – the clamouring consumerism, the brand's guiding light appearing on stage to deliver the next chapter to the gathered acolytes, the queuing-around-the-block fervour that used to be the sole reserve of new album releases – was pure Apple.

'We didn't expect it – we were so off with our predictions you'd laugh if I told you the numbers,' explains Jon McNeill, president of global sales and service. 'We certainly didn't expect queuing outside stores. The debut event was on the Thursday night, in Los Angeles. I went to our store in Costa Mesa – a small location for us, four employees – and there were 750 people lined up around the block. Elon was in north LA and it was the same thing. It was super-inspiring. For the first time we saw mass-market demand for an electric vehicle, and it was much bigger than anyone had anticipated, ourselves included.' With likeable understatement Musk tweeted 'definitely going to need to rethink production planning' in the wake of Model 3's unveiling.

Tesla's European facility, in Tilburg, Holland, may have a role to play. 'It's hard to predict things but it seems quite likely [that Model 3s will be built in Tilburg],' Musk told CAR last year. 'Based on prior experience that facility will likely be jam-packed a couple of years from now. With the Model 3 and some additional variations on X and S, we can get up to half a million units a year. We want to anticipate when that will happen, and build localised production in Europe, so when we hit the ceiling in California, our factory in Europe starts production. That's the ideal.' ▶

Rising to the challenge – from 80,000 cars a year to 500,000

TESLA'S FREMONT FACTORY is now racing to meet Model 3 demand. Publicly both Musk and McNeill say they were blind-sided by the magnitude of this demand, which doesn't bode well for a company with a reputation for delays. Its first car, the Roadster, was nine months late, the Model S six months late and the fearsomely complex Model X SUV delayed by eighteen months, thanks largely to those doors.

'It's a balancing act to deliver a car that's a unique and awesome experience on time,' says McNeill in Tesla's defence. 'Model X wouldn't have been the car it is without those doors. And we're always trying to maximise customer happiness.'

Tesla says the way it treats customers, fuelling this happiness, is almost as revolutionary as its cars. But its early adopters were wealthy individuals able to wait. Model 3 buyers will be different, and Tesla can't afford to fall out with them.

'We built just over 50,000 cars last year; this year we'll be in the 80-90,000 range,' explains McNeill. 'But when you look back to 2012 we were producing just a handful of cars. We've gone from that to producing nearly 100,000 units three years later, so we've had a very steep growth curve in terms of production.'

To keep that growth curve soaring Tesla is comprehensively re-thinking and modifying its factory, installing additional production lines modelled on those currently building Model X. 'One of the things Tesla is blessed with is the ability to attract talent, and we've done that on the manufacturing side. We are hellbent on becoming the world's best manufacturer. We've hired some manufacturing leadership that has taken other car models from zero to 500,000 units in a short period of time. That experience, combined with the creativity of the Tesla engineering team, is a pretty good set of ingredients. And we think about this place differently – for us this is the machine that creates the machines. That approach will lead us to those 500,000 units.'

In his recent 'The Master Plan: Part Deux' presentation Musk stated: 'A first principles physics analysis of automotive production suggests that somewhere between a five- to ten-fold improvement is achievable by version 3 on a roughly two-year iteration cycle. The first Model 3 factory machine should be thought of as version 0.5, with version 1.0 probably in 2018.'

Musk has said that Fremont will be building 500,000 cars a year before the end of 2018. 'Model 3 production will start in summer 2017, and we'll go as fast as we can through those 400,000 pre-orders, but we're going to be taking additional orders as we go,' explains McNeill.

The big question is how many of those 400,000 people Tesla can get a car to before they change their minds. Those deposits are refundable, and Musk has said he's not counting on them to pay the bills production expansion is generating, stating he 'doesn't want to rely too much on customer reservation money as a source of capital' and that instead this additional capital 'will impact our ability to be cash-flow positive for the year'. Cue groans from Tesla's shareholders. And while they no doubt wore smiles a mile wide when those Model 3 pre-order numbers were announced, those smiles will last as long as McNeill can keep deposit holders happy.



'We've hired leadership that has taken other cars from zero to 500,000 units in a short period of time' Jon McNeill

Tesla: can Musk pull it off?

The stakes are high, running to incomprehensible sums of money and, given that energy from unsustainable sources is exactly that – unsustainable – the future of civilisation as we know it. It takes some vision to try to change the embedded energy practices of an entire world but Elon Musk's track record suggests he has vision in spades: PayPal now moves hundreds of billions of dollars year globally and Space X, his space transportation business, has a string of firsts to its name, including putting the first privately funded, liquid-fuelled rocket into orbit and building the first commercial spacecraft to dock with the International Space Station. For now, at least, dirty fossil fuel fingerprints are all over Tesla, indirectly powering its cars in many instances, but there's a compelling logic to both Musk's sustainable strategy and his road map to it.

Tesla's influence has, in a few short years, grown exponentially, apparently unhindered by its inability to deliver sustainable profitability. In June 2016 a BrandZ report ranked

the ten most valuable car brands. Toyota was top at \$29.5bn. By contrast Tesla looks insignificant at \$4.4bn, at least until you consider its startling immaturity and almost insignificant production numbers relative to every other firm in the top ten. Porsche, which ranked ninth, has decades of (mostly) glorious road and racing cars in its back catalogue, and built 225,121 cars last year. Tesla's been making cars for six years and built 50,000 units in 2015.

That influence has undoubtedly already penetrated the product strategy of the established carmakers. A slew of premium battery-electric rivals from the likes of Mercedes, Audi, Porsche and Jaguar will arrive over the next couple of years. More conventionally-minded companies would panic as their relatively unchallenged position came under siege. But if we know one thing about Tesla it's that it's not conventionally minded and, hard though it may be to swallow, the official line is that this is about the greater good, not business.

'If someone buys a Nissan Leaf we win, because a combustion car comes off

the road,' says Jon McNeill. 'If someone else comes into the fold that's good – it means more people are coming to realise that there is an alternative. More people transitioning to sustainable transport means fewer people getting cancer and less of a global warming problem. To that end we've open-sourced our patents, to catalyse the electric vehicle market and make this happen faster.'

Much of Musk's new masterplan, announced in the last few weeks, makes a lot of sense. His plan to offer a battery-electric alternative for every form of ground transportation, from buses to trucks, is the obvious next move in his war on combustion engine road traffic. The Gigafactory is critical to the battery supply issue that threatens many of his ambitions, from delivering the panels and cells for home energy generation to Model 3's chances of success.

Timing is everything. If Fremont and the Gigafactory can deliver, this is just the beginning. If they can't, well, Tesla still wins – we'll end up where Musk wants us one day. It's just a matter of time. **car**

