

An aerial, top-down view of a car chassis on an assembly line. The chassis is silver and shows the internal structure, including the engine bay, transmission, and rear end. It is surrounded by various mechanical components and tools. The word "loop" is written in white in the top left corner.

loop

THE CHANGING FACE OF THE AUTOMOTIVE INDUSTRY

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Barely a day goes by without at least some mention of the transition to electric vehicles in the automotive media. But away from the stories of rapidly-approaching legislative targets and the shifts in consumer demand, there are other forces at work that are shaping the way the industry works and the challenges it is facing. Here, we look at three areas that are less well talked-about, but no less important, to an industry that is undergoing the most profound transformation since its inception.

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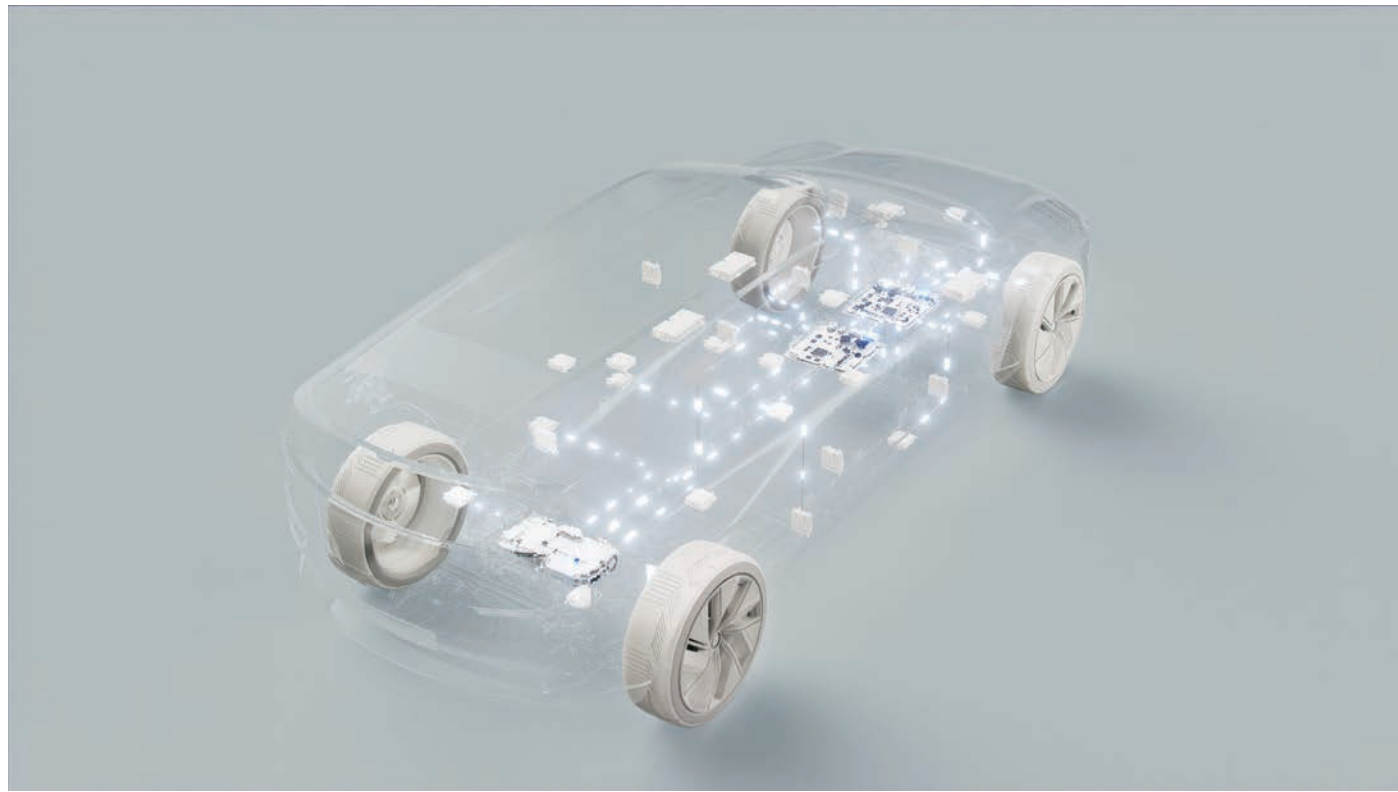
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THE ELUSIVE PROMISE OF THE SOFTWARE- DEFINED CAR

Beyond the switch to electric propulsion, there's another seismic shift underway in the car industry, one that is quietly reinventing the way vehicles are built. Welcome to the age of the software-defined car.



Modern cars carry hundreds of ECUs dotted around the vehicle, each with a specific task.



A central core replaces hundreds of disparate ECUs.

Modern cars carry hundreds of ECUs (Electronic Control Units) dotted around the vehicle. Each is responsible for a specific task – perhaps monitoring the climate control, or interpreting the signals from the parking cameras – and each is sourced from a different supplier as a unique combination of hardware and software, wrapped up in an impenetrable black box.

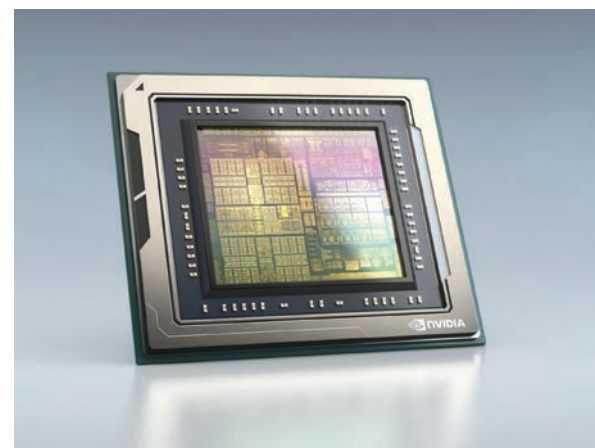
But when the semiconductor shortage began to bite, availability of this dedicated silicon became sporadic. Car makers responded by ‘decontenting’ their products, cutting out features that relied on hard-to-source parts, leaving customers short-changed and condemning a generation of vehicles to a lottery of makeshift specifications.

Particularly affected were legacy chips that automotive suppliers had relied on for years, attractive for their low cost. Chip fabricators had little incentive to invest multi-billion-dollar sums in building new foundries to churn out silicon that was already past its sell-by date, and this only compounded an already difficult situation.

Some manufacturers, however, took a different approach. Tesla deployed their army of developers to mitigate the effects of semiconductor supply issues by replicating certain functions in software rather than hardware. Volvo, meanwhile, took that principle further and started out on a journey that has seen them radically rethink the entire vehicle architecture, a path since trodden by Volkswagen, Hyundai and others.

Their approach is to replace the hundreds of disparate ECUs with a single powerful central core that acts as the vehicle’s brain, with all the software housed within it. Separating the hardware from the software like this simplifies the entire vehicle architecture, and that in turn reduces an OEM’s exposure to the vagaries of long-lead supply chains.

With a powerful compute platform – based on NVIDIA’s Drive Orin system-on-a-chip in Volvo’s case – many more functions can be implemented in software, massively reducing the physical integration work needed to bring a new car to market. Volvo cites an example of a two-year project that was completed in just three months when brought in-house, while bugs that would ordinarily take weeks of back-and-forth with third-party suppliers to resolve can now be squashed in a single work-day.



NVIDIA’s Drive Orin system-on-a-chip is the driving force behind Volvo’s implementation.

Should history repeat itself and a particular chip become subject to its own chronic shortages, switching to an alternative platform might require little more than a recompile of the existing code. And as the demand for legacy silicon abates, chip fabs can concentrate on ramping up production of these more horsepower-dense processors, driven by the prospect of higher margins and longer lifecycles.

There are other benefits, too. With fewer ECUs throughout the vehicle, there’s less interconnecting wiring – Volvo estimates 700 metres less cabling per car – and that cuts both weight and complexity. Fewer electronics lead to a reduced bill-of-materials, too, with fewer rare earth metals and improved energy efficiency, something that’s increasingly important for electrified powertrains.

The current crop of electric vehicles remain stubbornly expensive, yet car manufacturers know they need to do more to bring the price down if they’re to attract more than just the early-adopters and the well-heeled. Replacing all that expensive hardware with a few reusable software modules is potentially one way to achieve that.

This centralised architecture may help win another battle – the fight-back against the relentless march of the tech giants. As OEMs ramp-up their own in-house development capability, it places them in complete control of the customer experience and retakes ground lost to the ambitions of Apple CarPlay and Google’s Android Automotive.

This software-defined approach also means that cars will no longer be at their best the day they leave the factory and degrade as they get older. Over time, new and improved features can be released over-the-air, adding functionality or improving the driving experience for the lifetime of the vehicle. Or at least that’s the promise.

The transition from car maker to software house has been a struggle for some OEMs. There have been high-profile examples of cars arriving to market while still exhibiting bugs many would consider showstoppers. In extreme cases, manufacturers have been forced to buy back cars from customers due to unresolvable software issues.

There’s a risk the industry will use the software-defined platform as an opportunity to rush to market with an immature product, in the hope they can resolve the outstanding issues later. This forces customers to act as unrewarded beta testers, and since buggy software can’t be resolved with a box of spanners, franchised dealers are powerless to assist them.

Consumers are becoming wise to this, though. Their experiences with smartphones and other devices have shown them the speed with which today’s tech can become yesterday’s, rendered obsolete and unsupported as dev teams move on to the new and the shiny.

Car makers are going to have to work hard to convince them otherwise. Because in reality, the era of mechanical engineering is dead. We are in a new industrial revolution now. And this one is powered by software. ■

LIVING WITH CONTINUOUS DISRUPTION: THE STRUGGLE ON AUTOMOTIVE MANUFACTURING'S FRONT LINE

"WE'VE BECOME MASTERS OF HITTING THE GROUND RUNNING." It's an opener that hints not only at the sheer scale of the challenges the automotive industry has faced in recent years, but also the unprecedented degree of change it's had to navigate, and the impossibly tight timescales it's had to achieve it.

Much has been written about the pandemic, the global semiconductor shortage, and the drive to deliver net-zero. But less well understood by those outside the industry is what this has meant to those on the factory floor, the men and women tasked with physically delivering it. For them, there is no 'new normal.' It's a life spent at the cutting edge, managing a continuous stream of disruption. And for a glimpse into this world, we've sat down with a senior manager from a global robotics provider, whose clients' blushes we'll protect with anonymity.

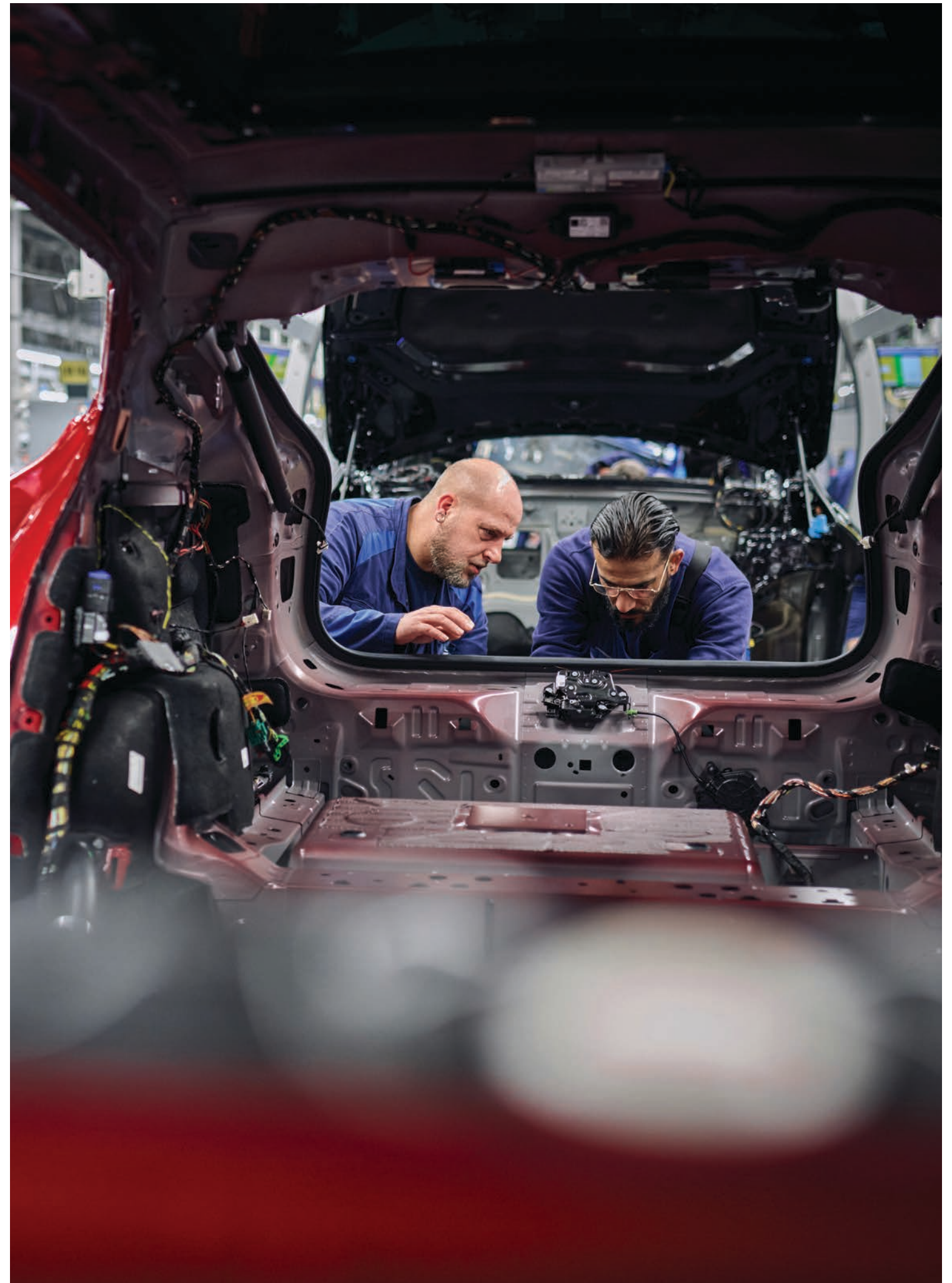
"Electric vehicles are new to everyone, and as a result their design is constantly changing, with no accepted best solution," he explains. "One project might use a particular motor design, but the next might use something completely different. Each will demand their own manufacturing processes, and both will be radically different to anything the industry has dealt with before. Where do you go to learn about this stuff?"

Electric motors aren't new to the industry. In the past, when selecting motors to drive electric windows or power seats, car makers would have outsourced production to their suppliers. But with traction motors so pivotal to the definition of an electric vehicle, this work is often now brought in-house. As a result, OEMs have had to learn about techniques such as varnishing – used to electrically insulate the internal windings and to protect

and secure them – a process that was previously completely alien to them.

"Do you hire new people with these skills, upskill existing workers, farm out their production, bring in consultants, or resort to an off-the-shelf part?" our man poses. It's a tough choice for any manufacturer. And no matter which route you take, there are staffing challenges to be resolved.

"Ultimately, society has changed, and that's hurt manufacturing," he tells us. Today's workers are far more willing to move, to travel, or even emigrate, and with manufacturing not seen in the same glamorous light as the likes of Silicon Valley, the automotive industry finds itself subject to high rates of employee churn.



“EARLY RETIREMENT, ACCELERATED BY THE PANDEMIC, HAS EFFECTIVELY TAKEN THE TOP LEVEL OF EXPERIENCE OFF THE INDUSTRY ENTIRELY.”

New roles promising the ability to work from home have meant many people have already left the industry, never to return, while early retirement – accelerated by the pandemic – has effectively taken the top level of experience off the industry entirely. And although the older workers that remain are more likely to stay put, their younger replacements – graduates in particular – are keen to gain experience before stepping-off to something else, somewhere else.

But these perceptions that cast automotive manufacturing in a negative light are often outdated. Smart automation, artificial intelligence and increasing use of virtualisation have made the industry one of the most exciting and cutting-edge places to work. Outreach programmes

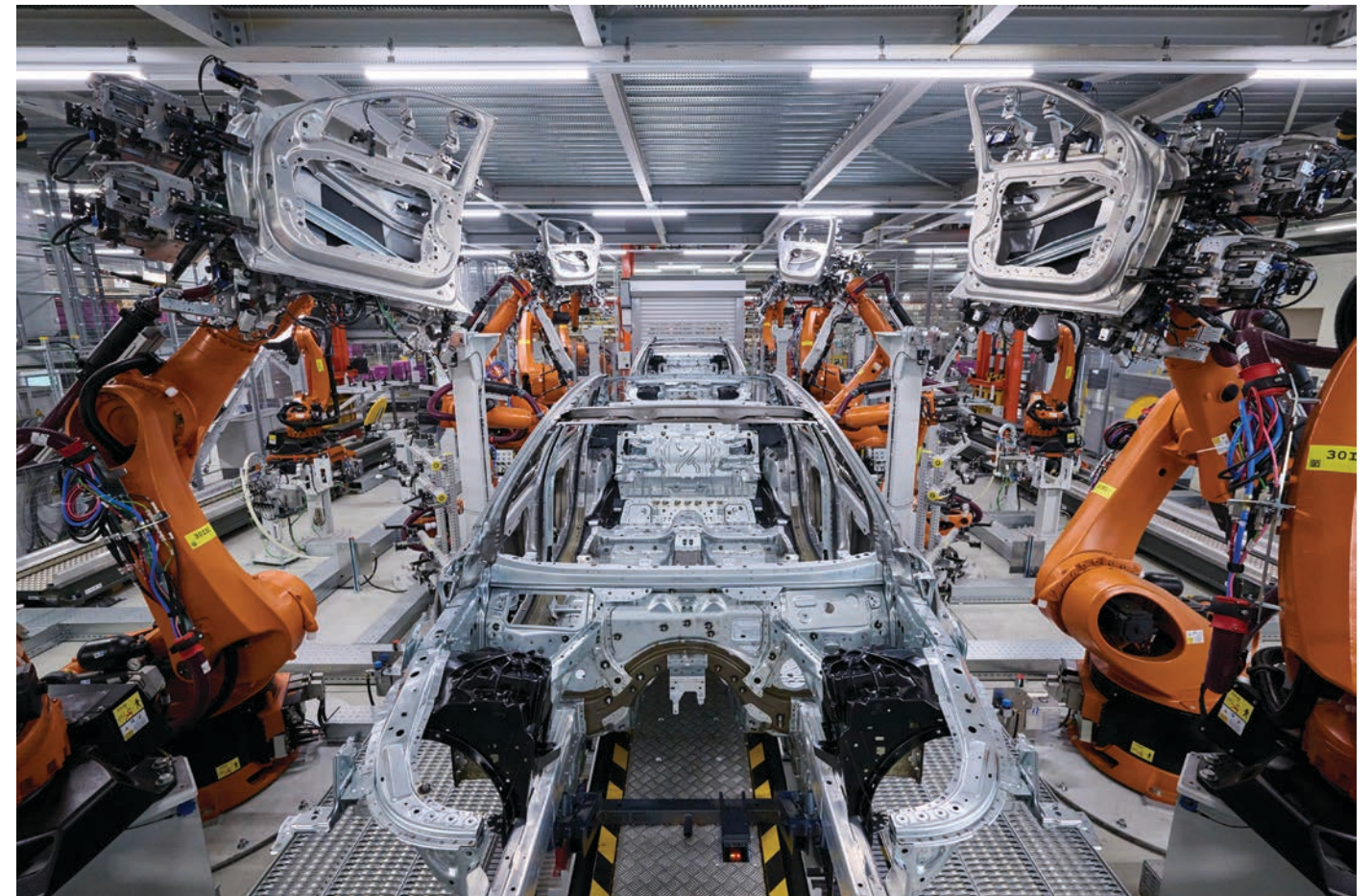
that collaborate with schools and universities to teach automation and software skills from an early age are helping to overturn the image of vehicle factories as something from a bygone age.

However, it's not just the workforce that's changing. The companies are, too. New start-ups have been quick to stake a claim on this new, electrified frontier, and although they've had to start from zero and learn everything from scratch, that's not necessarily a disadvantage when the incumbents are in the same boat.

Established OEMs are more likely to migrate existing workers into these new roles, whereas start-ups tend to use all new people, perhaps with some experienced personnel only at the high levels. That may bring with it a fresh

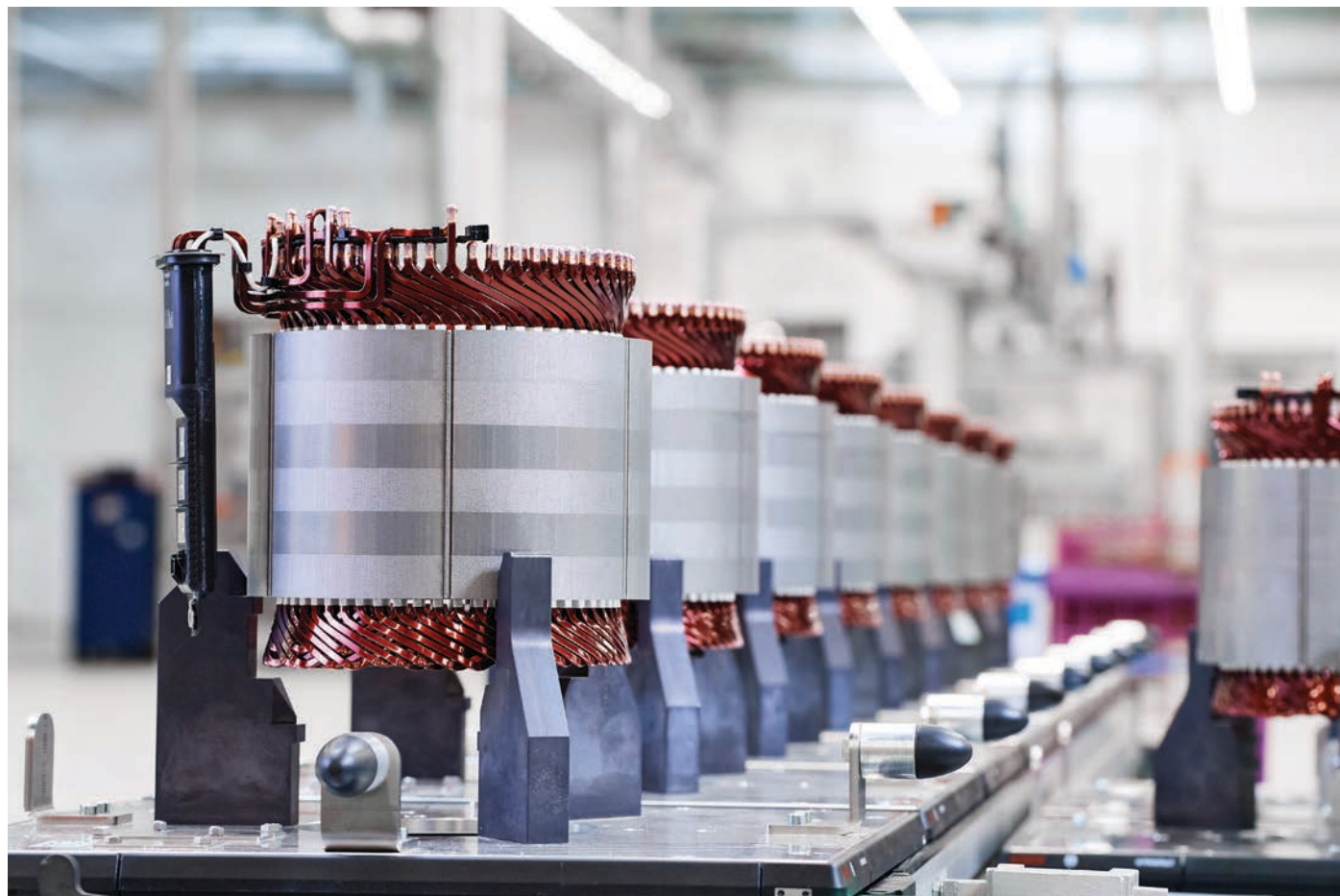
perspective, but in some common areas such as logistics, the important lessons can be hard to learn. “One client was handling a part four times to get it to the assembly line, wasting time, money, and increasing breakages. An established player would only need to do it once.”

In some areas, the experience of long-serving workers can be directly transferred. “One OEM moved their axle and transmission people from ICE assembly to EVs. That forced a whole new way of thinking upon them and created a steep learning curve, but it didn't take long for them to find opportunities to use their knowledge to improve the assembly process, even if that was something as simple as adding a locating pin to aid handling during assembly.”



The industry is more advanced than many imagine, with much of the manual labour now replaced entirely by automation.

Electric motor production is increasingly being brought in-house.



Often the rate of change in the industry is so great that the design of a product is altered before the production line has been completed. Gone are the days of pilot operations that saw lines built in a test facility for validation before being moved to the final production site. Now, demands are made for the line to be built in-situ and be capable of churning out product almost from day one.

In fact, so rapid can be the advancement of technology that production lines sometimes need to be built before the product has even been designed. “A recent project tasked us with designing a line to build six different parts, but only one had been finalised. When you don't even know basic requirements such as the part's dimensions, how do you know what to aim for?”

One can only imagine the degree of hair-pulling that must go on behind the scenes. But for our guy and his

team, there are always opportunities to design-in a certain amount of future flexibility. The rise of flexible manufacturing principles, for example, allow OEMs to start small and ramp up as demand increases. Traditional long-line production architectures are increasingly replaced by dedicated modular cells, arranged alongside the line like leaves on a branch, and this approach means cells can be added or modified without incurring costly interruptions to production.

Sometimes that's just as well. “For a project in the US, the customer made a late design change that meant that rather than a 100kN press, we needed 300kN. That's a highly specialised piece of equipment that doesn't exactly sit around on a shelf. With supply chain constraints, that introduced its own five-month lead-time. But, working with the client, we'll design a way of starting production with the current press and upgrade to the new process later on.”

Perhaps the industry will coalesce around a particular way of working as EV adoption becomes more widespread, although our contact is pragmatic about battery electric vehicles in general. “They might not be perfect for everyone, but despite the challenges of material supply, right now they're seen as the ‘best stone to step on.’ As the technology matures, it's likely a best practice will emerge and we'll look back on these pioneering days with amusement.”

That's unlikely to mean an end to the disruption, though. And with recent news revealing a slowdown by some players in their EV plans, might our automotive factories have to volte-face and pivot back to ICE technology? He seems unperturbed by the prospect.

“Whatever headaches the automotive industry has, we're confident we can develop the right medicine.” ■

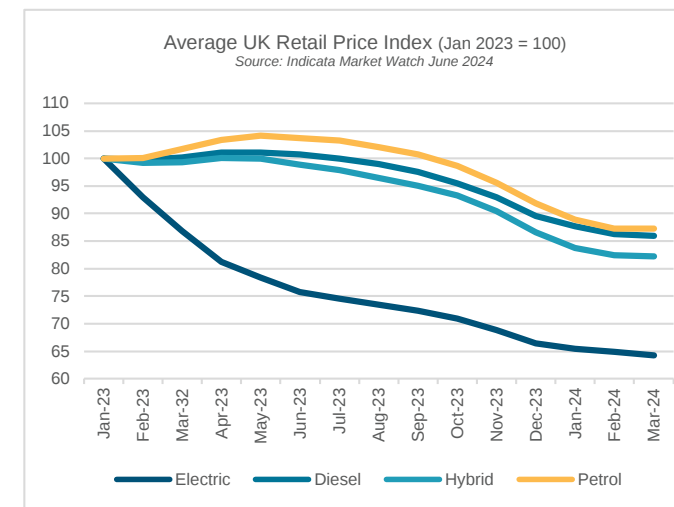
ACCESSIBLE BATTERY HEALTH INFORMATION IS VITAL TO BOOSTING BUYER CONFIDENCE IN USED ELECTRIC VEHICLES

DEMAND FOR NEW ELECTRIC VEHICLES has been growing in recent years, with sales of battery EVs long having surpassed that of diesel cars to make up more than 16% of the market¹. However, that's still short of the 22% required to meet the government's targets. In addition, used EVs have been having something of a bumpy ride, with recent SMMT figures suggesting they represent just 2.1% of the UK's second-hand market². Their values are falling, too, even in the current surprisingly buoyant market, with Auto Trader reporting³ that used EV prices have dropped 17% year-on-year.

A healthy second-hand market is crucial to maintaining sustainable new vehicle sales. Any softening in residual values leads to less competitive financing, making new cars less affordable and impacting sales. Used cars, by definition, are yesterday's new cars, and if new sales falter, that not only slows the EV transition and reduces the chances of achieving the government's targets – it also reduces the number of EVs on the forecourt, pushing used buyers back to their familiar ICE market. And while falling used EV values may be good news for canny buyers, Auto Trader reports that 9-in-10 new buyers also looked at a second-hand one, further exacerbating the situation.

What's happened to used EV values?

Analysis by market intelligence provider INDICATA Global⁴ shows that prices of used EVs separated from their ICE counterparts in the middle of 2020, with used petrol cars being worth the most, closely followed by diesels, and then hybrids.



Used EV prices peaked in Q3 2022 as demand and the semiconductor shortage weakened supply. But since then prices have been on a downward spiral as OEMs started to push discounted new and nearly-new EVs onto the market. This coincided with the first used EVs coming back to the market in volume from two- and three-year personal finance, leasing and salary sacrifice contracts. Demand could not keep up with this increased supply, and as a result, used EVs crashed in 2023 with prices falling by over 20% in just six months.

On the positive side, this led to sales of used EVs increasing by 67% to record their best year yet, with 118,973 transactions⁵ during 2023. However, when judged against the 7 million other transactions that made up the used car market that year, second-hand EVs still occupied a tiny corner of the marketplace, at just 1.64%.

Why aren't more people buying used EVs?

The same barriers people cite to their own personal EV adoption – such as the lack of charging infrastructure, no off-street parking, and the comparatively high price – are just as relevant to used buyers as they are to new car customers.

Crucially, however, there is one more concern that applies uniquely to the second-hand market: battery health.

Research by the Green Finance Institute⁶ revealed that fear of poor battery health is the single biggest barrier to EV adoption, with 62% of those who said they wouldn't buy a used electric car citing battery lifespan as the reason why.

Consumers' negative experiences with battery degradation in smartphones and other devices continue to reinforce this concern. However, while an iPhone will gladly report the current state of health of its battery, few – if any – EVs offer the same facility.

How can the industry address this?

Leasing companies, dealer groups and even auction houses are becoming increasingly mindful of this problem. Some have embarked on their own initiatives, similar to the familiar HPI check, to provide certification of a battery's health if it meets certain thresholds.

However, this fragmented approach is in danger of creating a series of competing standards that struggle to gain traction as a result. What's needed is an independent industry standard that all parties can sign up to.

Battery passports will become a legal requirement for all electric cars in 2027. Alongside information regarding the origin of their raw materials and their recyclability, it is also possible to store information regarding the battery's usage and its current state of health.

Battery management systems have become remarkably adept at accurately predicting a battery's remaining useful life, particularly those that make use of AI-powered algorithms and complex physics-based modelling. Given the already highly connected nature of modern vehicles, it would be trivial to expose this information to a potential buyer in an easy-to-understand format similar to that already available to smartphone users.

By making this information accessible to the consumer, used EV buyers could be provided with the reassurance they crave that a second-hand electric vehicle is not about to leave them stranded at the roadside with a dead battery and a hefty bill for its replacement.

For electric vehicles to move beyond the early adopters and into the mainstream, it is crucial that the industry delivers the consumer confidence necessary to underpin a thriving second-hand EV market. ■

¹ SMMT, new car registration data
² SMMT, used car sales Q1 2024
³ Auto Trader, The Road to 2035
⁴ INDICATA, Market Watch

⁵ SMMT, used car sales Q4 2023
⁶ Green Finance Institute, The Key To Unlocking Net Zero



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