Ricardo Quarterly Review **Q1** 2020

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The task of RQ is to highlight the latest thinking in global engineering and technology in the transportation and clean energy sectors and related industries. We aim to achieve this by presenting an up-to-date mix of news, profiles and interviews with top business leaders, as well as in-depth features on programmes – both from within Ricardo and other leading companies.

Client confidentiality is of the utmost importance to Ricardo, which means that we can only report on a small fraction of the work carried out by the company. So we are especially grateful to those Ricardo customers who have kindly agreed to co-operate with RQ and allow their programmes to be highlighted in print: without such help from customers it would not be possible to present such a fascinating insight into the development of new products, technologies and innovations.

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RQ INDUSTRY NEWS

The latest in technology, innovation and sustainability across world industries

BP commits to net zero by 2050

Was protester pressure a factor in BP's zero-carbon commitment?

BP's February pledge to cut its carbon emissions to net zero by 2050 took the fuels industry and financial establishment by surprise, but has already triggered an important follow-up response among other oil and gas producers – in Europe, at least.

All six of Europe's largest fuel producers have made broadly similar pledges, perhaps also in anticipation of the upcoming European Green Deal. Yet, as commentators have pointed out, detail is lacking and European fossil fuel firms represent only a fraction of global oil and gas production. No carbon-reduction undertakings have yet been made by US giants such as Exxon and Chevron, and the world's other major producers are largely state controlled and thus immune from the shareholder pressure that has been instrumental in forcing the hand of European firms.

BP, which boasted several years ago that its name would also stand for 'beyond petroleum', is setting a net-zero target for its own operations by the 2050 date, along with a halving of the carbon intensity of the fuels it directly produces. Excluded, however, are the carbon emissions from the generally larger amounts of fuels that BP buys and trades on the market.

Driving this initiative, new CEO Bernard Looney said that BP would invest more in renewables and that investor returns and cash flow were more important than production volumes. Nevertheless, BP's investment in fossil fuels will continue, though the company has withdrawn from several trade associations it believes are incompatible with its new outlook.

European Green Deal

With the ambitious aim of making Europe the world's first climate-neutral continent, proposals for a European Green Deal were published late last year, accompanied by a roadmap of key policies and priorities. Strongly supported by the new European Commission president Ursula von der Leyen, the plan sets a target date of 2050 for overall carbon neutrality; all 27 EU member states, with the exception of Poland, are onboard, though the pace of the necessary changes is still disputed.

The centrepiece of the legislation will be a landmark climate law which, in another area likely to invite controversy, may be automatically updated and its emission targets revised at five-yearly intervals from 2030 onwards.

The proposals come against a background in which several member states are trying to transition away from coal, and where the latest energy efficiency figures show that the bloc's progress is well short of the pathway required to achieve even the earlier package of improvements.

Who's who in the carbon countdown

Many hundreds of companies and organizations have already signed up to the variety of indices and registers that have sprung up to highlight which firms are taking climate action aimed at carbon neutrality by 2050 or, in many cases, earlier.

In January Microsoft, which had earlier pledged a 75 percent cut in its GHG emissions, significantly raised the stakes by promising to become climate negative by 2030. This signifies that it would seek to begin removing carbon from the atmosphere, a technology which has yet to be proven at scale. More ambitiously still, Microsoft is also undertaking to eradicate its entire historic carbon footprint by 2050, removing all the carbon it has emitted since the company was founded in 1975.

In February the London-based Energy and Climate Intelligence Unit reported that just under half the world's annual GDP is now covered by nations, regions and cities that are legislating for a net-zero emissions target. Ten months ago, just 16 percent of GDP was covered by such targets.

The show that never happened

The last-minute cancellation of the Geneva Motor Show meant that a clutch of futuristic electric vehicle concepts were denied their moment of public glory – and that several new near-production EVs will first encounter one another on the open road, rather than on the show floor.

Renault's Morphoz concept car is impressive in its refined style, its 400 km range and its clever extendable wheelbase, which provides extra space for a drop-in battery pack to give a claimed total range of 700 km. Hyundai's riskily-titled Prophecy appears more of a sleek style statement than an obvious engineering exercise, and PSA's DS Aero Sport Lounge also breaks new ground in terms of its silhouette and finishes.

Very much closer to production are Volkswagen's ID.4, the SUV element in the VW Group's high-stakes electric car offensive, and the BMW Concept i4, a barely disguised version of the Tesla-baiting i4 electric crossover due to go on sale in 2021, some months after the VW.

But perhaps the most daring newcomer is the fresh Fiat 500 *(pictured)*, described in the presentation video by Leonardo di Caprio as "the third reincarnation of an icon, not just the third generation". Giving credibility to di Caprio's boast is that the new 500 will be electric only: it claims a range of 320 km on the WLTP or 400 km in the city.

EV breakthrough cars?

Responding to the universal sentiment that electric vehicles are too expensive for the mass market, two French automakers have unveiled rival models that seek to bring battery power to a broader audience.

Citroën's Ami *(right)*, first shown as a concept last year, arrives in production form as a tiny, 2.5-metre urban two-seater that can be driven without a car licence. With a top speed of 45 km/h and a full-charge range of 70 km it is aimed at city car-share fleets, and for cash buyers it will be seen as a comfier alternative to a scooter or moped.

From the Renault group comes the Dacia Spring *(above)*, shown here in concept form and due to enter production in 2021. Claiming to be Europe's most affordable electric car (though no prices are yet confirmed), the four-seater, five-door Spring has a range of 200 km and is in the currently fashionable urban SUV mould. Renault points to its past successes with its Dacia value brand, including the Logan family sedan and the Duster SUV: could the Spring do the same breakthrough job for battery power?

NEWS **IN BRIEF**

Highlighting the latest thinking in automotive engineering and technology worldwide

GM's battery breakthrough

General Motors has announced a major electric offensive centred around a range of in-house motors and a new generation of battery technology. Labelled Ultium, the new batteries have pouch cells that can be stacked vertically or horizontally, giving greater power density. Packs from 50 to 200 kWh will allow ranges up to 650 km, says GM, with trucks employing 800-volt systems and cars 400. Among the new electric launches will be a fresh Bolt EV in late 2020.

Two motors good, three motors better

Audi's upcoming line of sporty 'S' editions of its electric models will have what the company claims is a worldwide first in mass production – a drive concept with three electric motors. The motor on the front axle is now larger and more powerful, and twin motors on the rear axle provide electrical torque vectoring for more agile handling. No differential is fitted. In normal driving the rear motors power the car, with the front disconnected unless grip conditions deteriorate.

Honda: 400,000,000 and still counting

World motorcycle leader Honda has celebrated its 70th birthday with a cumulative total of 400 million units built. Thirty-five factories in 21 countries have built bikes ranging from the ubiquitous 50 cc Cub to the 1800 cc Gold Wing, with the 100-million mark being reached in 1997, 200 million eleven years later, and 300 million in 2014.

High precision positioning

Hyundai used the forum of January's Consumer Electronics Show in Las Vegas to present a new and highly accurate vehicle positioning system. The result of a collaboration between the Korea-based manufacturer, Swedish autonomous solutions provider Hexagon and leading supplier Valeo, High-Precision Positioning works by applying a correction to the GPS signal received by the vehicle, allowing its location to be determined to within a centimetre. This compares with GPS technology's 1.5 to 2 metres. HPP will be showcased on the 2020 Hyundai Sonata.

Cadillac enhances driver aids

The GM-developed SuperCruise part-automated driving aid has been upgraded for the 2021 model year and now incorporates an automated lane-change capability. All the driver has to do is engage the appropriate turn signal and the vehicle will wait for a suitable opening before merging into the desired lane. When introduced in 2018, SuperCruise was the first system to offer semi- autonomous driving to SAE Level 2.

Electrics outsell manual cars

In 2019, for the first time, more buyers opted for electric vehicles than bought models with manual gearboxes – in the US, at least. According to *Green Car Reports*, which requested the figures from Power Information Network, the third quarter of 2019 saw electrics overtake manuals, with a 1.6 percent market share, manuals fading to 1.1 percent of US retail sales for the year.

Pickups lead EV power race

Despite enjoying the heady boom in the US heavy pickup market, manufacturers are eyeing up solutions that might offer a more sustainable future. Battery drivetrains, with their high power and huge torque, have exactly the characteristics that truck buyers prefer, and on such bulky vehicles weight is not an issue.

Ford has already announced an all-electric F-150, as well as its Mustang Mach E SUV, and Tesla's launch of its powerful Cybertruck drew large online audiences. Ford's luxury brand Lincoln will use the skateboard chassis from newcomer EV specialist Rivian, with which it already has links, and now GM has announced the return of the larger-than-life Hummer brand. Set to be revealed in May, the GMC Hummer EV truck promises no less than 1000 horsepower and 15,000 Nm torque – enough for 0-96 km/h in three seconds.

Newcomer Nikola, which has won recognition for its Tre range-extender semi-truck combination, is in on the game too. Its Badger pickup employs similar technology to the Tre but with a 120 kW fuel cell topping up its 160 kWh lithium-ion battery pack and supercapacitor array. With peak horsepower of 960 and 1330 Nm torque, the truck seats five and is claimed to hit 96 km/h in a tyre-shredding 2.9 sec. Maximum range is said to be 965 km and production is set to begin in 2021 with an as-yet unnamed automaker partner.

Nikola already has a deal with Iveco to build the Tre truck in Germany from 2021, and Iveco is part of CNH Industrial, which is linked to Jeep owner Fiat Chrysler.

GM's famed Hummer brand is set to return this year with a 1000 hp electric truck

CO_2 fines force policy rethink

European automakers and importers are bracing themselves for a shock this year as new and more stringent fleet-average CO_2 emissions come into force, backed by heavy fines for those manufacturers who overstep their prescribed targets.

The news that new-car CO_2 emissions rose for the third year in succession in 2019 will add another level of worry for companies. Figures from Jato Dynamics show that Europe's volume-weighted average climbed 1.3 g to 121.8 g/km, its highest level since 2014.

From this year, the overall average fleet CO_2 emissions are set at 95 g/km, a limit which will tighten by 37.5 percent by 2030.

Under the EU's new system of penalties, automakers face a fine of €95 for each gramme over their limit, multiplied by the number of vehicles they each sold in Europe in that year. Volkswagen, with multiple millions sold in the EU, could face fines of as much as €4.5 bn, according to a study by PA Consulting. Automakers face different target averages, dependent on the weight of their vehicle ranges, and giving producers of smaller and lighter models a more challenging task.

Yet there is also consensus that 2019's market was distorted by a number of factors. Automakers were keen to bring forward sales of their high-emitting gas-guzzlers into 2019 rather than having them counted in the stricter regime of 2020, and many suspect that some EV sales were held over into 2020, where they provide their makers with supercredits. And it is no coincidence that the new wave of 48-volt hybrids now appearing not only help flatter brands' CO_2 averages but provide credits, too.

Period piece shapes up for the 21st century

Morgan's hand-built sports cars are famed for their unchanging style, and so it is with the new Plus Four. It may look just like its 70-year-old ancestor, but it swaps the wooden frame for a bonded aluminium platform, and the four-cylinder BMW turbo engine gives 255 hp – which goes a long way in a two-seater weighing just 1013 kg.

New hybrids, novel transmissions

Renault is a conspicuously late arrival at the hybrid party but on the evidence of the new Clio, Captur and Mégane E-Tech it has used the delay to bring some promising new transmission technology.

The entirely clutchless system has two dog gearboxes, a two-speed for the e-motor and a four-speed for the gasoline engine, with the electric motor helping with rev-matching to ensure smooth shifts. Both boxes have a neutral gear, too. The arrangement allows electric launch and city driving, with the combustion engine disconnected; at highway speeds the e-motor is decoupled and the gasoline unit drives the wheels directly.

Honda's new Jazz is hybrid-only for Europe and has a similar but simpler layout. The gearbox is single-speed , allowing the gasoline engine to power the wheels in a linear fashion at higher speeds; in town, and for manoeuvring, the system works as a series hybrid, with the e-motor channelling the battery and engine energy to the road.

Electric vans: independents step in

Major automakers and commercial vehicle builders may have been missing a trick when it comes to eco-friendly last-mile delivery vehicles – a sector that has been thrown into sharp focus thanks to the growing acceptance of zero-carbon targets for 2050 or earlier.

Deutsche Post, which owns DHL, bought Germany's fledgling StreetScooter company in 2014 after the country's biggest car builders declined to develop electric vans, though Ford later helped on the manufacturing side.

Recently, Amazon announced an order for a massive 100,000 vans co-developed with electric SUV startup Rivian, which also has links with Ford: the van will make use of Rivian's self-contained skateboard chassis.

Earlier, UPS, which has long pioneered its own vans powered by renewable gas, as well as electric cargo delivery bikes, commissioned the UK's Arrival startup to build 10,000 electric vans. These will be based on Arrival's second-generation EV architecture. Independently, Korean giant Hyundai Kia announced a major investment in Arrival.

As early as 2018 IKEA committed to making 100 percent of its home deliveries emission free by 2025 and it is working with a number of smaller firms – including Australia's SEA - in its different regions to develop local last-mile solutions. Already, Shanghai deliveries are 100 percent electric.

Image courtesy of Rivian

The sounds of silence

Audio engineers are in high demand as automakers tap into the next big thing in the EV market – alluring brand-authentic sounds to warn pedestrians of the silent vehicle's presence.

Fiat made a big play of the "orchestral" repertoire available with its new, all-electric 500 city car, making a point of contrasting its generous warm harmonies with the synthetic beep of a German model and the dull moaning sound emitted by a major French model.

BMW, for its part, says its IconicSounds Electric will "imbue electric models with extra emotional depth by connecting the driver with the vehicle's character on another level through individual tones and sound". Even opening the door or starting the engine form part of BMW's automotive soundscape and, perhaps ominously, Fiat made a connection between the individualized e-sounds chosen by drivers and the personal ringtones they download for their smartphones.

VIEWPOINT

Why fuel cells are best for zero-emissions long-haul trucks

Andrea Trevisan, chief engineer, commercial vehicles, Ricardo Automotive & Industrial

Pure battery electric commercial vehicles are commercially attractive for many different tasks, whether for local deliveries using small to medium capacity trucks, or for larger vehicles used in captive operations such as drayage in and around port complexes. However, for the typical duty cycle of the ubiquitous long-haul heavy trucks, on which our modern industrial economy is built, the pure battery electric powertrain presents rather more of a challenge.

To illustrate this view we need to consider the duty cycle of the inter-city truck. The average journey for international road freight transport in Europe is about 600 km and, depending on the payload, the standard range for a long-haul truck is about 800 to 1000 km; sometimes this can be extended further with extra-capacity tanks. This is the required range of a long-haul truck and this is the range that any new concept of truck powertrain must deliver.

To assess the viability of a fully battery powered truck, Ricardo has assumed a range of 800 km and a payload of 44 tonnes. At this load level, according to Ricardo tests, the average energy consumption is about 2 kWh per km, meaning a battery with capacity of 1600 kWh would be required. At 2020 prices this translates to a cost of about US $397,000 just for the battery pack. By 2030, according to the UK Advanced Propulsion Centre, the cost could have fallen to US $200,000. Battery pack weight – which would subtract from load-carrying capacity – is estimated as 8900 kg in 2020 and 4000 kg in 2030.

Conversely, for a fuel cell truck powertrain a rule of thumb for first dimensioning is that battery capacity can be taken as approximately one-tenth that of the corresponding fully electric vehicle. This means that for an 800 km range, a fuel cell system rated at about 200 kW and a battery pack of 160 kWh can be considered in the first instance. This matches the performance of a 44-tonne heavy duty truck which typically is equipped with a 13-litre six-cylinder internal combustion engine of 320 to 380 kW and has an average fuel consumption at full load condition of about 50 litres per 100 km.

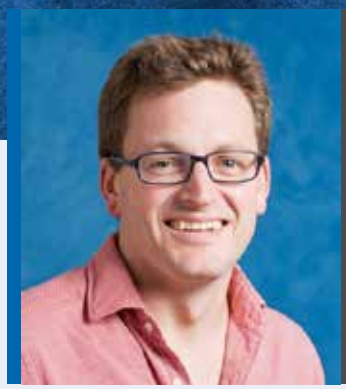
"I would argue that electric long-haul trucks will only be economically viable when fitted with a fuel cell powertrain"

Based on the these assumptions, and compared with an available payload of a diesel-engined truck of 31,000 kg, a fully battery-powered electric vehicle would offer a payload of just 23,000 kg in 2020, rising to around 28,000kg in 2030 if we take into account the forecasted improvement over the next decade in battery energy density. As an alternative option, the fuel cell truck allows a payload of 29,500 kg today, rising to 30,000 kg in 2030.

Payload and range have always been crucial to commercial viability in the heavy-duty long-haul transportation sector, and this will be no different for the zero-emissions trucks of the future. While short-haul, last-mile delivery and drayage operations may be particularly well suited to the pure battery electric powertrain, a different solution – and one that impacts far less on the operational payload capacity – is in my view required for longer haul, heavy duty trucks. Moreover, in an industry where cost is king, our total cost of ownership (TCO) modelling indicates that by 2030, the fuel cell based long-haul, heavy-duty truck powertrain is about 20 percent lower cost in terms of payload tonne-kilometres than a pure battery electric solution.

For these reasons, I would argue that electric long-haul trucks will only be economically viable when fitted with a fuel cell powertrain. This allows for relatively small batteries and thus only a minimal reduction in payload and range - which is precisely what the long-haul operators require.

RQ INTERVIEW



Who's driving my car?

Artificial intelligence is being promoted as the key to future autonomous driving technology – but is AI as intelligent as it's made out to be? To find out, **Ian Adcock** talks to **Dr Jack Stilgoe**, associate professor of science and technology studies at University College London and a Fellow of the Alan Turing Institute

It's not long ago that fully autonomous driving was being talked about in a 2030 timeframe; now that is being put back by 30 to 50 years. Will it ever happen?

It's not a question of when, but of where. There will be autonomous driving in some places, in some circumstances, on some roads, at some speeds, relatively soon. That's [done through] geofencing and you need to be clear what the operational design domain is. On other roads or places, it remains impossible forever. Most of the time when people are making predictions it's to sell something; predictions are always wrong.

Most people need a few dozen days to master driving. Those basic driving skills can be transferred from grid-locked London to rural tracks; computers need to 'learn' from existing data and can struggle to cope with new scenarios.

The language of AI is very misleading; it's assumed that because a computer is better at chess than a human, it will be better at driving, but computers will drive in very different way. There will always be very different types of mistakes. Driving is about engaging with an uncertain world, not just about controlling a vehicle and understanding what other drivers are doing and what they're likely to do. You get machine learning to understand what the rules of the road are, but when engineers start testing they realize you need to programme in some rules very explicitly. For instance, what's the passing distance between a cyclist and a car? This is one of those rules drivers routinely break, so what do you tell an autonomous car to do in those circumstances?

I am doing a lot of work at the moment on the Highway Code, which is an extremely interesting rule book because those rules are not fixed: there are lots of grey areas. So teaching a self-driving car how to engage with that is a really interesting challenge. How much is it a self-driving car [itself] learning to drive, and how much do those cars need to be taught to drive by humans with our existing understanding of the rules of the road? It has to be both.

> **"It's not a question of when, but of where. There will be autonomous driving in some places, in some circumstances, on some roads, at some speeds, relatively soon"**
>
> **Dr Jack Stilgoe, associate professor of science and technology studies, University College London**

Humans use general knowledge and instinct to react to new and unexpected events, but are AI-controlled cars liable to mishandle 'edge cases'?

Edge cases are really interesting because, as humans, we think that everything we encounter is new. No cyclist is exactly the same, let alone peculiar examples such as someone crossing the road with a big set of balloons. But how you make an automated system adapt to those environments is a huge challenge, which is why we will only see self-driving cars in circumstances where edge cases are least likely to appear. One thing you might see [is that] roads and junctions get designed to suit autonomous cars. The American four-way stop junction is a nightmare for autonomous cars: traffic lights are much easier, as they regiment the process of who goes when. The world is an unpredictable place, but there are places where road use is more predictable and it's no coincidence that's where autonomous cars are being tested first. Artificial intelligence is not trying to mimic the human brain despite what some AI enthusiasts say: AI is trying to solve very specific problems. Yes, it can be really good at chess, but hopeless at cooking your breakfast. To talk of AI in terms of general intelligence I think is misleading, although it tends to be the way it's presented, largely because it suits those developing AI.

How do you get AI to seamlessly amalgamate camera, LiDAR and radar inputs without one taking precedence over the others?

The challenge of being omniscient for an autonomous car [is] that it has to see everything – [but] that's missing the point. You might have the best sensors, but working out how to balance the input from all those sensors is the most important thing. It's a design problem as to how you make sense of all that data.

It can take a driver up to 40 seconds to regain control of a car once an alarm has sounded. As autonomous cars become better, won't this skill atrophy become even worse?

That's well known among pilots – so-called automation complacency, which some developers of autonomous cars are just discovering. When you put a human into a smart system that person often becomes much less smart in various ways, and a human in the loop to take over in safety-critical situations is a really

> **"If we are serious about tackling the safety problem, then we have to look at where the dangers are. If people were serious about tackling road safety, they would have done things other than develop self-driving cars"**
> **Dr Jack Stilgoe**

dangerous proposition. One way to circumvent that is by not putting people in situations where they have to take over at a moment's notice. Which is why some autonomous car companies are saying that they won't even give people the possibility of control: on this journey the car is in charge all the time.

Because it's difficult to blend autonomous cars with those driven by humans, would it be easier to re-engineer cities to support lower levels of autonomy and/or robo-taxis?
That's exactly what happened with the arrival of the car, particularly in America. That's why traffic lights were invented, jaywalking was banned and roads tidied up – to suit the needs of a particular technology. We can imagine that happening with autonomous cars. That will be easier in emerging cities than in the West. In effect we're saying we can't deal with all that complexity, so we make the world more predictable by keeping pedestrians and cars segregated. The AI engineer would say that with enough data you can reach something approaching perfection. But by engineering in that sort of complexity there is also pressure to engineer it out [from the external environment]. In effect it is saying *'We can't deal with all of that complexity so we will make the world more predictable.'* You see this in other autonomous technologies that control the environment as well as the robot.

What's your answer to the 'trolley problem' where AI has to make a choice between two outcomes, each of which is harmful in a different way?
It's a non-issue – a distraction from the real question that engineers and policymakers have to confront. The trolley problem is a thought experiment, not a design challenge: it was never conceived to be an actual problem for decision-making by autonomous agents. It presupposes a world in which a robot is able to distinguish between types of people and make value-based decisions on that assessment.

The irony is that where autonomous driving is needed the most, it is unaffordable, both in terms of vehicles and infrastructure
If we are serious about tackling that problem, then we have to look at where the dangers are. If people were serious about tackling road safety, they would have done things other than develop self-driving cars. Road deaths in the USA are three times higher than the UK or Sweden, and if America wanted to do something about it, they could. It is odd that autonomous cars are seen as the solution to the US problem of many people still not wearing seatbelts - and that's part of the paradox.

Who is responsible for an autonomous car's actions?
We don't know at the moment; it still needs to be worked out. That's complicated in all sorts of other ways, by vehicle users blaming automakers for not updating their software, or by drivers not using the technology correctly. This has happened in other forms of automation, so it's never going to be a straightforward answer. The history of automotive law has been that carmakers were, in effect, absolved from producing dangerous objects although those objects are, potentially, enormously dangerous.

Isn't the main problem with AI that it is artificial and not intelligent, and should therefore play the role of a mentor rather than chauffeur?
What you will see is the application of this technology in different ways in different circumstances , [circumstances] where we can be confident that the world is sufficiently predictable for the computer to do the driving. RQ

Dr Jack Stilgoe is associate professor of science and technology studies at University College London and is a Fellow of the Alan Turing Institute. He runs the *Driverless Futures?* project (driverless-futures.com) and is the author of *Who's Driving Innovation?* (Palgrave)

A Nissan Leaf *[below]* **completed UK's longest autonomous drive: the 370 km between the firm's research centre and its factory in Sunderland. Continental's Urban Mobility Experience** *[below right]* **is a prototype automated urban delivery robot**

On-demand consulting

for a transforming world

Launched in December 2019, Ricardo TRNTY provides access to a curated global network of independent expertise, carefully selected from millions of potential profiles. The new service, pronounced 'trinity', will provide the ultimate in flexible consulting support, based on in-depth subject matter and industry-specific knowledge, skills and experience

The world of work is evolving rapidly, and across the modern industrial and consumer economy the emergence of new technologies and parallel innovation in business models are transforming the commercial ecosystem.

As we head into the 2020s it is all change: shared-use connected and automated vehicles, electrified road transportation, app-based ride hailing services and the online sourcing and delivery of a plethora of products and services previously sold via high-street shops and showrooms. With agile innovation and the emergence of these new technologies, fresh approaches to customer service become possible - offering new avenues for competition while disrupting and rendering obsolete those long-established models of business.

Organizations hoping to succeed or even just survive in this rapidly changing world are realizing the need to adapt and innovate in both their products and services, as well as in their internal processes and external customer interfaces. This in turn is propelling a new demand for specialist skills and expertise.

The use of specialist independent consultants or niche consultancies is increasingly seen as essential to bring in new knowledge and fresh ideas based on experiences outside of a company or even an industry. The benefits of using independents go far beyond the economic advantage of not needing to increase headcount or engage with

big-name management consultancies. As a part of its Workforce 2020 study, Oxford Economics reported that over 80 percent of the 2700 executives surveyed said that they were increasingly using 'contingent' employees, defined as non-payroll personnel including intermittent and seasonal employees, consultants, freelancers and part-timers. The trend was found to be global and to cut across major industrial sectors.

But this trend is more than just a case of companies looking to access external specialist consulting support. In parallel with this demand-side change, there is also an emerging appetite amongst many skilled professionals to seek a more independent and more dynamic working lifestyle than full-time salaried employment. This has helped fuel the growth in the number of individual specialist workers seeking autonomy, the fulfilment of diverse career or project experience and the flexibility to improve work-life balance.

In a 2019 article, for example, Forbes magazine reported that against the backdrop of 45 percent of employers experiencing difficulty in filling open positions, a significant and increasing proportion of the workforce – estimated by Intuit as likely to exceed 40 percent in 2020 – will be involved in contingent work. Such a projection is broadly in line with the experience of technology giant Microsoft which, Forbes stated, operates on the basis of having two-thirds as many contractors and independent specialists as it does headcount employees.

A new concept for a new era

Sam Hassall joined Ricardo as business unit leader during 2019 to spearhead the development of the TRNTY service as business unit leader. He explains how the idea was conceived to address these societal and business trends: "For some time I'd been providing an external talent identification service to Ricardo Strategic Consulting (RSC) to help build its management consulting team.

"In talking to RSC's MD James Passemard," he continues, "I explained my concept of 'expertise as a service.' The idea was to enable automotive and off-highway companies to source consultancy as an on-demand service – expertly curated and subject to transparent customer and consultant reviews – rather than seeking the help of the far more expensive management consulting firms. James told me that he had also been planning to develop exactly the same business model. We quickly decided that we really needed to develop this concept together."

The Ricardo TRNTY concept is so named because it is based upon three pillars: agility, quality and delivery, which as a combination provide a seamless network between the clients and the independently delivered expertise. With rapid engagement from project inception to completion, the service breaks down the barriers in the conventional model of consulting, providing customers with immediate access to a quality-assured global network of expert consulting support that would be beyond the capability of even the largest consulting firms. At the same time, the TRNTY network offers an advanced framework through which expert consultants and niche consultancies can offer their services as independent and highly skilled professionals.

In this respect, TRNTY effectively emulates, in a completely different area of business, the approach used by advanced technology-driven, gig-based and freelance platforms such as Fiverr or UpWork, or even app-enabled ride-hailing firms such as Uber and Lyft. TRNTY's advanced technology helps ensure accurate, rapid deployment, but is more closely focused on the automotive, mobility, transportation, energy and environment industries.

Technology is employed for the sourcing, project matching, deployment and performance monitoring processes. However, the importance of human interaction throughout the entire process is not ignored. Every time a new project requirement is launched, a dedicated TRNTY team is put into place to ensure projects are accurately matched with the right associate. While the project is running, both clients and associates can provide feedback on how well the project is being delivered and, if an issue occurs, the TRNTY team can step in.

Integration with Ricardo

Hassall explains that the new service complements existing Ricardo businesses rather than competing with them. "We see TRNTY as effectively entering a white space. For example, whereas Ricardo Strategic Consulting projects are typically oriented to strategic-level analysis and recommendations, perhaps lasting a few weeks, TRNTY projects are more likely to be focused on taking strategy forward through implementation and market roll-out. Our customers will often be looking for a deep level of domain expertise and this is something that we can provide across a vast number of areas."

People's desire to work in a freelance capacity is growing fast, says Hassall: this applies across many levels of career experience, from fresh recruits just a few years into their careers in areas such as blockchain, V2X or highly advanced coding, right through to those with many decades of industry expertise and knowledge.

"Many TRNTY projects are are likely to

"Our customers will often be looking for a deep level of domain expertise and this is something that we can provide across a vast number of areas"
Sam Hassall, TRNTY business unit leader

require one or more key individuals with strong leadership or technical skills built up over years or even decades, as well as associates with highly technological expertise," he explains. "This is where the real power and value of TRNTY comes in. For example, we might resource a project with an expert in manufacturing who knows the subject inside out, combined with a smaller consultancy specializing in Industry 4.0 and a team of technology experts with a deep understanding of blockchain and IoT technologies. You could build an extremely powerful team capable of taking on the ultimate challenges in smart factory and digital manufacturing, phasing in each element of the team as the project evolves."

Platform for SME innovation

Beyond the enrolment of individual specialist associates and consultancies, TRNTY can also create tailor-made teams comprised of, for example, various specialists, consultancies and even Ricardo headcount, to enable the delivery of a plug-in/plug-out solution that will meet the evolutionary requirement of a major project.

"We see an opportunity to attract small, highly specialized consultancies to form part of the TRNTY global network," continues Hassall. "For example, we might find a consultancy specializing in augmented reality, which can be applied to advanced mobility or smart city projects. As compact teams with relatively few members, those agencies can form part of the TRNTY universe, enabling them to offer their services directly to worldwide clients who would otherwise be unaware of their advanced capability, insights and knowledge. While this might make less sense for larger organizations, for smaller start-ups, specialized consultancies and even certain types of university spin-out TRNTY can offer an extremely good fit."

"TRNTY is addressing new and more specialized emerging market requirements with a fundamentally new and innovative business model"
Sam Hassall, TRNTY business unit leader

Scalability and future-proofing

Hassall is confident the TRNTY model offers the potential for massive scalability: "As the project numbers grow, the level of automation and machine learning incorporated in our platform means that the administrative and managerial overhead needed to support business growth is comparatively modest – we simply don't require anything like the operational headcount that would be needed if we used the more conventional global consulting business model."

On the face of it, it might seem that the upfront investment in this technology platform is an aspect which represents a barrier to entry to new competition. But in many respects the development required by Ricardo to create it has been comparatively small. There are similar models in specialist areas such as the legal profession and for very generalist areas of industry. What makes TRNTY different is its much greater focus upon specialist skills and vertical integration within its targeted industries. It is this knowledge and the understanding of these core sectors – for which Ricardo has long been known – that is likely to attract independent associates to enroll with TRNTY, and for clients to be confident that they are engaging with a service backed by a deeply knowledgeable specialist provider.

"TRNTY is addressing new and more specialized emerging market requirements with a fundamentally new and innovative business model," concludes Hassall. "As a concept it is far more powerful and valuable to our customers – and to independent experts – than the sum of its parts." RQ

Recognizing RISK

Hurricanes, floods, wildfires, sea-level rise – the effects of climate change will impact almost every business worldwide. Regulations will tighten, too, but how do companies evaluate the real risks they face? **Tony Lewin** reports on a new global initiative that is helping firms assess their risks and develop resilient strategies to protect their businesses in a fast-changing world

"Global temperatures are on course to increase by 3.4°C by 2100"... and there will be "ferocious typhoons, record-breaking heatwaves and major landslides..."

Remarkably, these are not the angry words of a banner-wielding, sandal-clad climate activist interviewed at one of last summer's city-centre protests. Instead, they are the measured phrases of a highly respected pillar of the banking establishment – no less a figure than Mark Carney, the outgoing governor of the Bank of England.

The fact that Carney has made climate change the central theme of so many of his recent speeches shows how profoundly the financial sector is beginning to change. Boardrooms are beginning to take notice of what is going on in the broader world outside their own spheres of activity, and some have even begun to take on board the risks that

climate change poses to the medium- and long-term future of their operations.

At the same time, the Bank of England revealed that it would begin stress-testing financial organizations against climate risks, in much the same way as it already carries out balance-sheet stress tests on banks.

As if proof of this watershed was ever needed, BlackRock, the world's largest investment fund manager, declared at January's World Economic Forum (WEF) in Davos that it would stop investing in fossil fuel stocks, and intended to be more interventionist in its voting within companies it invests in. "Awareness [of climate change] is rapidly changing," said chief executive Larry Fink in an open letter to BlackRock clients, "and I believe we are on the edge of a fundamental reshaping of finance."

BlackRock's announcement is something that Tim Curtis believes is of pivotal significance. As managing director of Ricardo Energy & Environment, he keeps a very close eye on developments within the business and financial sectors; he takes particular note of Fink's new stipulation that companies BlackRock invests in will have to sign up to regular declarations explaining how they plan to deal with the risks associated with global overheating.

"BlackRock was seen as one of the laggards," says Curtis, "so its declaration will definitely have a major material impact, given their might." BlackRock's move was one of the main talking points at the WEF, and as one of the most influential players in the venture capital field, it will give a major boost to international initiatives aimed at encouraging climate awareness in the financial sector and persuading companies and investors to make business declarations that reveal the risks – and opportunities – presented by the changing climate.

Change of mindset

It has been a long time coming, but many of the principal players in the global financial sector – famous for its aversion to standard risks, but blind to climate effects – have finally begun to accept that climate change is perhaps the biggest risk of all.

Now the boot is on the other foot and the business and financial establishment is on the verge of a massive about-turn. Instead of climate-related investments being seen as risky ventures, forward-looking managers have woken up to the far bigger risks posed by failing to invest ⇢

The Ricardo perspective

As group risk manager for the Ricardo Group, Andrew Swayne has been engaged in the company's internal TCFD project from its inception. Here is his experience so far:

"TCFD is both enlightening and challenging. Being able to overlay climate change on our existing scenarios has given great insight into how we embed climate change into our enterprise risk management processes. We did realize that we had already looked at many of these risks prior to setting a formal climate change agenda, though in some instances the process demands enhanced content. In the early stages of the process it was critical to get a balanced view across our divisions, engaging enough stakeholders from operations, strategic leaders and functional heads. Having already established *Creating a world fit for the future* as the company mission made this much easier.

"When it comes to exploring scenarios, we can already learn from the rapidly moving coronavirus situation, something which reminds us of the most basic needs of our citizens. It's a lesson to all businesses to remember the needs of our ultimate customers – citizens who earn money and spend it. Everyone will need to refresh their crisis responses and business continuity plans.

"At Ricardo we have developed an excellent approach to upgrading our roadmap to follow the TCFD model: the task now is to establish how the business can best use this model as we approach TCFD readiness. An important thing we have already learned is that that starting early enables a phased approach, so that climate change can be built into annual strategy and budgeting cycles.

"A major challenge is to evaluate the financial opportunities and impacts over timescales that are extended far beyond the longer term financial planning cycles of most businesses. What's needed is draft regulations which work internationally to provide guidance on how to do this. These new horizons are much further out than the customary timescales for disclosures such as viability statements. And whilst TCFD currently focuses purely on listed companies, it will be interesting to see how its principles are adopted by the public sector and the larger privately-owned businesses."

Andrew Swayne
Group risk manager, Ricardo plc

> **"Firms that align their business models to the transition to a net zero world will be rewarded handsomely. Those that fail to adapt will cease to exist"**
> **Mark Carney, outgoing governor, Bank of England**

in measures that benefit the climate.

At a meeting of the Task Force on Climate-Related Financial Disclosures *[see box on page 18]* in Tokyo last October, Mark Carney came up with this stark warning: "Changes in climate policies, new technologies and growing physical risks will prompt reassessments of the values of virtually every financial asset. Firms that align their business models to the transition to a net-zero world will be rewarded handsomely. Those that fail to adapt will cease to exist. The longer that meaningful adjustment is delayed, the greater the disruption will be."

Ricardo's Jamie Pitcairn, technical director for the circular economy and sustainability, concurs. "It's more than just corporate social relations – it's about the continued existence of your business and what changes need to be made to your business model as business as usual is not an option," he observes pointedly.

The River Ouse in York, UK, bursts its banks *(above)***, while in Ho Chi Minh City in Vietnam** *(left)* **scooter riders brave the flood waters**

Task force

Even before the turn of the millennium it had become clear that normal market forces, all too often focused purely on short-term gain, were unlikely to persuade major companies to acknowledge climate risks in their future planning. Yet a group of enlightened central banks could see the threat to long-term financial stability and, through the international G20 organization, established the Task Force on Climate-Related Financial Disclosures, or TCFD.

Comprised of 32 members, from a variety of international financial institutions both public and private, the TCFD has developed a standardized framework for companies to ascertain and disclose the climate-related risks expected to confront their organization in the future.

Although TCFD reporting is technically still voluntary, it is expected to become near universal within two or three years, adds Carl Telford, manager of strategy and futures at Ricardo Strategic Consulting: "National central banks are already supporting TCFD through the financial system. In the UK every bank and pension fund and every insurance company has to go through the process, and this will force it into the real economy."

For individuals, adds Telford, "your risks are coming from the companies you are exposed to – and after BlackRock's move in January I expect most other companies to follow suit. It will be a massive risk for companies that don't do it, and they will no longer be seen as investment-grade stock. After all, as an investor, would you put money into a company that doesn't understand its own risks?"

The pressure will build internationally, too, he elaborates. "As soon as there is regulation in one or two G20 markets, you'll see the rush. Global companies based in India and China, for instance, are heavily reliant on overseas investors. They'll do it."

How does TCFD operate?

Tim Curtis is at pains to point out that the TCFD process is much more than a tick-box exercise. "Because of the pressure on companies to disclose this information in their financial and strategic reports, we know from experience that you have to look at everything from materiality and scenario planning to the strategic and financial impacts."

Curtis argues that it is much better to acknowledge your risks and be clear that you have a plan: "That's what is seen as good management."

The Task Force has issued a series of communications to help companies with their climate-risk reporting. The process is linked in to a firm's policies on environmental and social governance: it is here that the notion of financial materiality comes into play, factoring in influences which could have an effect on the company's future position. How climate change will be material to a company's operations will depend on a wide range of factors, including the nature of its business, its geographical location, and its supply chain.

TCFD also asks companies to carry out scenario analysis to explore how they would respond to a range of hypothetical future scenarios such as a 2-degree rise in temperatures, a 1-metre rise in sea levels, or a carbon price of, say, $100 a tonne.

The TCFD process draws in the top-level managers and specialists within the company, the underlying objective being to ensure that there is a senior management function in the boardroom overseeing climate risks. The Bank of England has mandated this as compulsory for banks and insurance companies in the UK since October 2019.

Cataloguing the risks – and the opportunities

It is something of a lazy management cliché that behind every risk there is an opportunity. Yet for all the disastrous consequences it threatens us with, climate change does present big opportunities for those who acknowledge it and have the courage to adapt their business models in good time. Tesla is a good example of a company ahead of the game in the migration to electric vehicles, and even Britain's National Health Service says a transition to net-zero carbon emissions could save it money.

"That's why today we are mobilizing our

Types of risk

The effects of climate change pose a wide range of risks to businesses; some risks are so serious that a company may have to change its business model or cease operation altogether. Here are some of the risks TCFD takes into account:

• **Physical risks**	Floods, droughts, wildfires, sea-level rise, desertification
• **Liability risks**	Risks that could intensify due to a possible increase in litigation
• **Structural risks**	Major change in how regulations, markets or technologies operate could impact across the entire structure of a business
• **Transition risks**	Risks and costs involved in migrating from a legacy technology to a new one
• **Reputational risk**	Damage to a company's standing or image caused by faulty technology or failure to move with the times
• **Stranded assets**	Plant, equipment, land or technologies made worthless as they no longer comply with updated standards or regulations

1.3 million staff to take action for a greener NHS," said chief executive Sir Simon Stevens, "and it's why we'll be working with the world's leading experts to help set a practical, evidence-based and ambitious date for the NHS to reach net zero."

As for the fossil fuel industry, as has been widely discussed, a zero-carbon world represents an existential threat to their business. "Oil and gas assets total some $20 trillion," observes Jamie Pitcairn, "but if we are stick to the Paris figure of a 1.5-degree temperature rise, 80 percent of these assets will become worthless – they will become stranded assets. As an investor, you would have to consider that."

Yet if that same company were to put forward a coherent transition plan to divest from fossil fuels, its appeal to investors would be transformed. The imperative of disclosure and early action to diversify is clear for to all to see. In February this year incoming BP CEO Bernard Looney surprised the City with a pledge that the oil major would aim for net-zero carbon emissions by 2050: however, in the absence of concrete plans to achieve this, the market reaction has so far been muted.

> **"Companies that don't do TCFD will no longer be seen as investment-grade stock. As an investor, would you put money into a company that doesn't understand its own risks?" Carl Telford, manager of strategy and futures, Ricardo Strategic Consulting**

On the other side of the coin are the opportunities that clear TCFD declarations open up for investments. The knowledge that TCFD declarations are to a common format and adhere to strict rules gives provides a further layer of respectability to investments in climate-mitigating programmes, boosting their appeal to investment fund managers and private investors alike.

Torrential rain in Miami, Florida *(above)* **and wildfires nearing houses in southern California** *(right)*

"Better TCFD disclosure is an opportunity," adds Mark Carney. "Research by the Bank of England and PwC finds a positive correlation between companies' stock price and the number of TCFD disclosures that firms make. This could be because investors reward companies that are leaders in managing climate-related risks or simply because TCFD adoption identifies companies that are more naturally disposed to longer-term strategic thinking and planning."

Task Force on Climate-Related Financial Disclosure

The TCFD was launched in 2015 as a subset of the Financial Stability Board (FSB), itself constituted in 2009 by the G20 group of major economies. The founding Chairman of the TCFD, Michael Bloomberg, remains in post. The mission of the Task Force is to develop voluntary, consistent climate-related financial risk disclosures for use by companies in providing information to investors, lenders, insurers, and other stakeholders.

The Task Force considers the physical, liability and transition risks associated with climate change and what constitutes effective financial disclosures across industries. The TCFD's 32 members were chosen by the FSB to include both users and preparers of disclosures from across the G20's constituency, covering a broad range of economic sectors and financial markets.

The Ricardo approach

Through its Energy & Environment and Strategic Consulting divisions, Ricardo is already working with a selection of high-profile clients across a number of sectors to prepare TCFD declarations. The process involves seven distinct steps and begins at board level to give critical insight into climate risks and the need to embed climate risks in strategic planning, enterprise risk management and investor

How TCFD can help businesses

- **Better access to data will enhance how climate-related risks are assessed, priced, and managed**
- **Companies can more effectively measure and evaluate their own risks and those of their suppliers and competitors**
- **Investors will make better informed decisions on where and how they want to allocate their capital**
- **Lenders, insurers and underwriters will be better able to evaluate their risks and exposures over the short, medium, and long term**

information; the materiality of those risks is then assessed and vulnerabilities identified.

Next comes scenario planning, where the company anticipates its response to plausible future climate-related eventualities – anything from floods and droughts to changes in the regulatory environment or political developments. The business impacts of each of these are explored and responses identified, culminating in a set of decision-useful recommendations to inform the company's strategic policy thinking.

As a final step, the whole process, including all the inputs, outputs and response options are documented and summarized for inclusion in the company's governance report.

TCFD example: water shortage

As one example of how the TCFD process could operate, consider a major clothing retailer looking to assure its long-term future. With extensive manufacturing operations in south east Asia, the retailer's business is dependent on a number of factors outside its control. Among these are labour and transport costs, but perhaps a much bigger issue could be water. The production of cotton requires a large amount of water, and increased water scarcity is one of the very real risks of climate change. The scenario planning process within TCFD could explore the company's options should water availability decline or disappear, and scenarios could even model the financial consequences of a switch to a different raw material such as bamboo.

Outlook

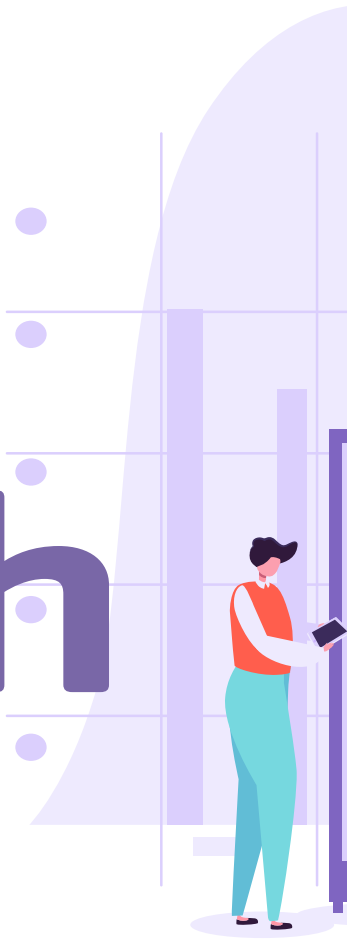
The take-up of climate-related financial disclosure is set to accelerate rapidly as more companies are brought into the regulatory framework and others realize the advantages of advertising their resilience in the face of climate effects. Investors stand to gain, too, with an objective yardstick with which to compare competing investment opportunities.

For companies themselves, the close focus prompted by the disclosure process can in itself prove a valuable strategic planning tool, helping map out future options and allowing for quicker and better-informed decisions should circumstances change. Even in the shorter term the process can highlight areas where efficiency improvements can be made, many with short payback times.

Bringing climate expertise into the boardroom will help directors refine their thinking when it comes to deciding the risk appetite of the company, possibly opening up new investment opportunities and closing off others, extending the planning horizon and allowing first-mover advantage.

Where Ricardo adds a further dimension is in its globally recognized expertise across the spectrum of environmental disciplines, giving unique insight into the assessment of climate risks and the potential exploitation of technologies and innovations that help companies generate climate-resilient returns.

From information overload to Research Clarity



Desk-based research is a crucial first step in guiding almost every new project, whether it is product development or scientific innovation. **Anthony Smith** speaks to the team behind Ricardo's new RiCK™ service that combines AI technology and expert curation to help users improve the quality of their research – and save time and cost, too

A literature review is often the foundation stone of almost any research project – whether it is an undergraduate assignment or the work of a Nobel laureate, or even the product development of a new electric vehicle or the planning of future space exploration.

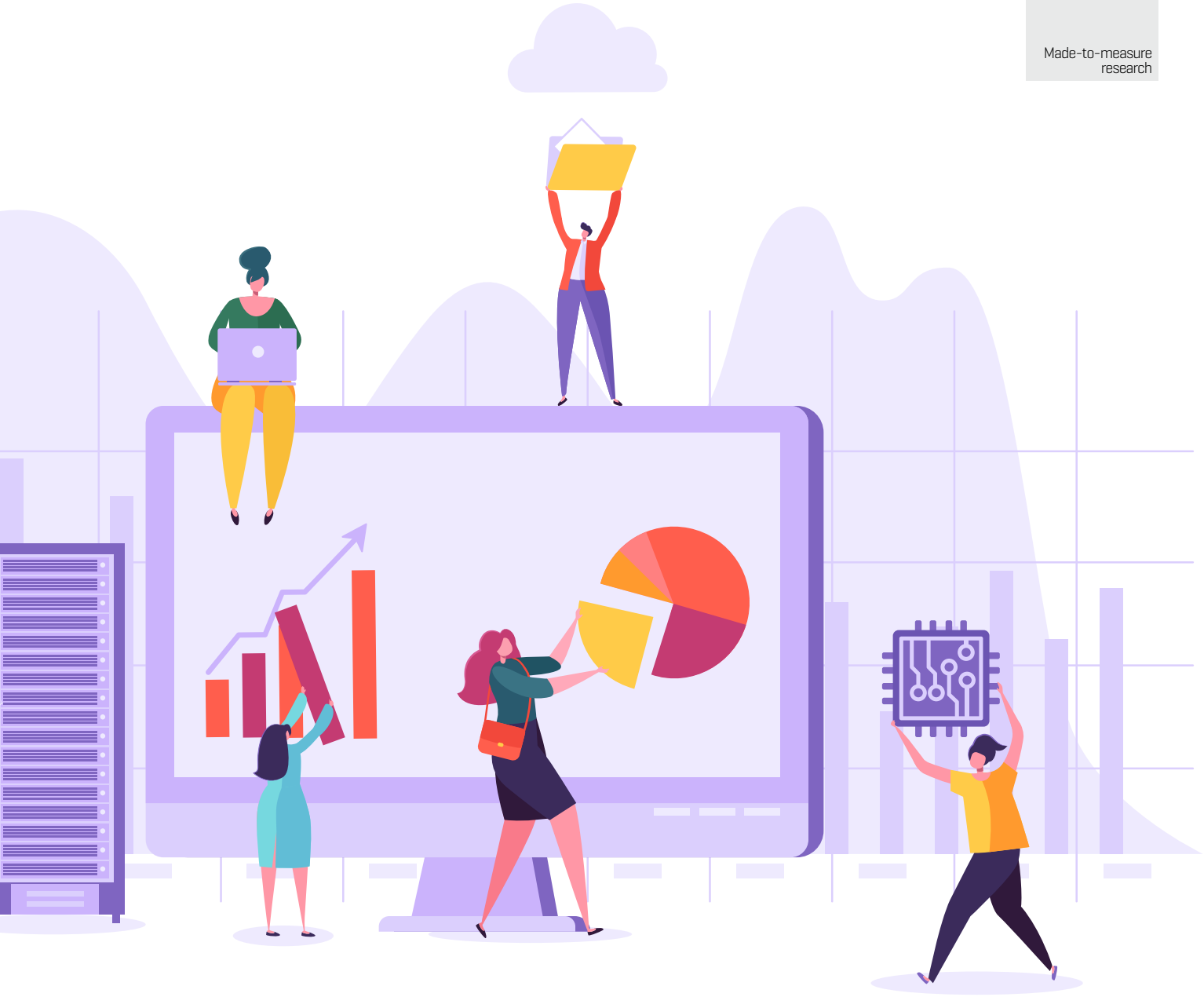
But while efforts at innovation bring us an unprecedented range of technologies, products and services touching almost every aspect of our lives, they are all bounded by the universal laws of nature and physics that have existed throughout history. So, logically, why would any of us tasked with creating something new, better or more attractive not first evaluate what has been done before?

This is a sentiment that echoed in Mark Twain's adage of just over a century ago that "there is no such thing as a new idea. It is impossible. We simply take a lot of old ideas and put them into a sort of mental kaleidoscope. We give them a turn and they make new and curious combinations".

Desk research in the pre-internet era required a high level of skill: for example, in navigating the many volumes of abstracts and indexes of a research library. But does it necessarily follow that universal tools such as Google have reduced the need for this aspect of research by placing the research library at the disposal of all of us? In many respects, the democratization of news output and information gathering of the digital age has brought with it both positive and negative outcomes. While the internet enables the commercial and societal benefits of dissemination of information on an unprecedented scale, fake news, disinformation campaigns and the misappropriation of intellectual property can have deeply corrosive effects too. So in today's world, is top-quality research information now just a mouse-click away?

Information: chasing quality, not quantity

In the view of Ricardo Knowledge commercial manager Jo Ross, the answer is both yes and no. "Google certainly brings an unprecedented amount of searchable data within the reach of anyone with internet access," she says. "The challenge



with such open tools, however, is that of sheer information overload."

Ross cites the case of a simple search in Google using the term 'commercial vehicles'. This, she says, produces over one billion hits. Even with more prescriptive search terms to narrow the field down, there is little or no distinction between the quality of sources, and it becomes a significant task of work to sift, filter and qualify the quality of information of relevance to the research task at hand.

Ricardo Knowledge has long provided an externally accessible curated database covering the international automotive, transport engineering and energy sectors, together with an expert-led library and information service available to both in-house engineering teams and external subscribing companies. However, while this commercial library service has always generated an extremely high level of customer satisfaction and repeat business, the team was keen to create a new package of services that more closely matches the needs of an increasingly digitalized approach to research and product development.

External perspectives

In designing the new RiCK service, Ricardo sought the opinions of existing and prospective customers in terms of their approaches to research. Previous third-party studies had indicated that the amount of time devoted to searching for information can have a significant influence on costs for businesses, as well as a massive impact on productivity: many engineers and other professionals can spend the equivalent of almost one working day per week on this activity.

This level of commitment is illustrated in comments by Brian Macey, fuel product development advisor for energy company BP: "Searching for information is time-consuming. At the beginning of the project process, team members can spend almost all of their time finding information. If we say an average project lasts around two years, for the first two months a team will spend most of its

Key requirements identified for RiCK

- **Citations – an easier and more automated way to add citations to documents**
- **Shared working spaces – recognizing that teams may be working in parallel using the same online research tools and may thus miss opportunities for collaboration**
- **Ratings and reviews – a built-in review facility helps give an indication of how useful other technical specialists had found a document**
- **Regular email updates**
- **An easier way to search documents either conventionally or by keyword**

> **"Google certainly brings an unprecedented amount of searchable data within the reach of anyone with internet access. The challenge with such open tools, however, is that of sheer information overload"**
> **Jo Ross, Ricardo Knowledge commercial manager**

time searching for information and, after that, members will dip in and out again as they need to. For example, if the size of a team is 30 people, the [aggregate] research time spent might be the equivalent of one to two people full time."

One of the problems Macey identifies is that his team finds that searches can either seem to produce thousands of results or nothing: "We'd like to get to a place where we can easily find, say, 20 pieces of relevant, useful information. If a paper has a well written executive summary, it's a godsend as you quickly know if it's relevant or not.

"A consultancy like Ricardo may have useful information for our team as they may have already collected the type of outcomes we are looking for, and may have collated similar information that will help us with the problem we are trying to solve," he continues. "We're usually looking to make vehicles as fuel efficient as possible and to reduce emissions. It's just important that our technologists know how to search, and which search criteria to use."

RiCK – an intelligence-driven approach

It was feedback such as this, together with research into some of the latest digital content aggregation technologies available, that led to the specification for the new RiCK service. At its core, the RiCK service is an updated database, which is continuously refreshed with the latest research publications. The database contains over 300,000 abstracted references from trusted sources, including industry-leading papers and articles from the automotive, transport engineering and energy sectors. Content abstracted for RiCK includes technical conference papers, journal articles, industry reports, white papers and press releases. Over 500 new entries are added and curated for the benefit of subscribing technical teams each month.

"The most important advantage is that the database is fully curated by subject-matter experts and is focused on the international automotive, transport engineering and energy sectors," explains Jo Ross. "Our dedicated information specialists, Donna Wild and Clair Sharpe, review and tag all of the entries in the database to enhance search accuracy. Moreover, as part of the Advanced Search service, they can provide expert tuition in research techniques or even carry out paid searches on behalf of customers."

The RiCK team combines years of research and insight experience in the use of Boolean, natural language and key word search techniques to help customers find the most appropriate, useful and actionable information. "All of these enhancements enable RiCK subscribers to find trusted secondary sources and technical research content quickly and efficiently," continues Ross.

Further RiCK services

In addition to the database, the RiCK news service provides tailored specialist news content, aggregated from over 80,000 news sources and expertly curated by Ricardo's technical and information and knowledge management teams. This service is ideal for thought leadership and competitor analysis projects and allows customers to keep up to date in specialist areas of technical expertise and endeavour.

Also available is a collection of high-level technology roadmaps produced by Ricardo experts, analyzing and projecting the likely evolution of a range of technologies to 2030 and beyond. These roadmaps cover light duty gasoline and diesel engines, heavy duty diesels, power electronics, e-motors and battery technologies.

In packages offering further enhanced levels of service, RiCK subscribers have access to trusted information specialists to assist with their more complex search requirements. The RiCK team combines years of research and insight experience in information management.

Modular service delivery

Recognizing the differing research needs and the varied commitments and available external budgets of customers, the RiCK service is initially being made available at three levels of provision. At the most basic level, the RiCK News service provides a tailored, sector-specific content aggregator that allows customers to keep up to date with the topics that are important to their business.

The next level of service is RiCK 1.0. This covers unlimited access to the online curated database, while at the highest current level RiCK 2.0 provides both of the above plus a listing of upcoming conferences, along with selected high-level Ricardo technology roadmaps, three months' access to the Advanced Search support service, and monthly and quarterly newsletters such as Hybrid & Electric Powertrain News, Autonomous Vehicle Update, and Fuels and Lubricants News.

"We're currently market testing these three service levels and consulting with customers with a view to bringing forward a further RiCK 3.0 product in the coming months," explains Jo Ross. "This is likely to include all of the capabilities and features of the level 2.0 service but with enhancements providing further access to Ricardo subject-matter expertise, and an even richer research experience."

> **"This new database and package of associated information and research services combines the power of technology together with the curation expertise of our information specialists to capture and process information from a broad range of sources"**
> **Angela Johnson, head of knowledge and technology strategy, Ricardo Strategic Consulting**

Outlook

Following the promising start to the new RiCK offering, the enthusiasm for the future of this innovative research service is echoed by Angela Johnson, who as Ricardo Strategic Consulting's head of knowledge and technology strategy carries overall responsibility for the product: "The launch of the RiCK provides customers with a highly effective package that can save time and improve the effectiveness of technical, market and competitor research across international sectors such as automotive, transport engineering and energy.

"This new database and package of associated information and research services combines the power of technology together with the curation expertise of our information specialists to capture and process information from a broad range of sources."

Johnson concludes: "Available in a range of different service levels to suit the requirements of individual customers, I believe that RiCK will provide a highly valuable tool to help subscribers improve the effectiveness, efficiency and the speed of their research efforts."

Services Levels

	RiCK™ NEWS	RiCK™ 1.0	BEST VALUE RiCK™ 2.0	LAUNCHING SOON RiCK™ 3.0
The Database		✓	✓	✓
Specialist Subject Newsletters	✓ One Subject Monthly		✓ One Subject Monthly	✓ Multiple Subjects Monthly
Forthcoming Conference list			✓	✓
Case Studies				✓
Technology Roadmaps			✓	✓
Advanced Searches			✓ 3 Months access	✓ Full access
Ask the Expert Engage with subject matter expert for Q&A and Analysis				✓
News Bulletins Monthly & Quarterly			✓	✓
eLearning				✓

Meet the RiCK team

The RiCK service was conceived and developed, and is delivered by, the Ricardo Knowledge team, which includes [L-R]: Louise Scott, knowledge management coordinator; Ritika Belwariar, new product introduction manager; Clair Sharpe, senior information specialist; Jo Ross, Ricardo Knowledge commercial manager; Angela Johnson, head of technology strategy and Ricardo Knowledge; Cody (Yi) Yang, RiCK digital information assistant; and Donna Wild, client information specialist.

RICARDO NEWS

Latest developments from around the global Ricardo organization

GM Defense teams with Ricardo on ISV

GM Defense ISV prototype: Ricardo co-operation

GM Defense LLC has selected Ricardo Defense Inc. to support key product 'logistics and fielding' requirements associated with its execution of the U.S. Army's Infantry Squad Vehicle (ISV) project.

In June 2019, the U.S. Army awarded a $1 million contract to GM Defense to develop two ISV prototypes for testing and evaluation. A production and deployment contract award decision is expected later this year.

GM Defense's ISV is based on the Chevrolet Colorado ZR2 architecture, which employs 70 percent commercial off-the-shelf parts in a flexible, light, all-terrain vehicle. Ricardo Defense will assist GM Defense with integrated product support, typically consisting of vehicle technical manuals and training materials for operators and maintenance personnel.

"We're excited to join forces with Ricardo Defense to significantly strengthen our submission for the ISV contract pursuit," said GM Defense president David Albritton. "Ricardo's experience with military fleet readiness, performance and sustainability, combined with GM's expertise in engineering, manufacturing and product quality at scale, creates a powerful team that is able to meet and exceed the Army's demands for this platform."

High speed commuter rail for Seoul

Ricardo Rail's Seoul-based team will provide system engineering support during construction of Line A of the South Korean capital's planned high-speed commuter rail network; the support will continue through to the line's planned opening in 2024.

Ricardo has been appointed by SG Rail Ltd – the Special Purpose Company that will finance, design and build the GTX-A railway – to provide multi-discipline engineering and assessment services during the development of Line A of the Great Train eXpress (GTX), the new higher-speed network for Seoul and its surrounding commuter region.

As the first of three standard-gauge lines planned for the new network, GTX-A will extend from Unjeong in the northern reaches of the Seoul region through to Dongtan in Gyeonggi province to the south of the city. With just ten stops along its planned route, including the city's main Seoul Station interchange, the line will operate at speeds of up to 180 km/h, allowing end-to-end journey times of just over 40 minutes. This is less than half the time taken by the current metro services.

Ricardo will provide system engineering and Independent Safety Assessment (ISA) services to ensure the infrastructure (track and civil engineering) and rolling stock systems (vehicles, communications, signalling, and so forth) are properly integrated and ready to provide a safe and efficient service once operations commence. System engineering activity will include oversight of integration management, as well as providing expert support on RAMS (reliability, availability, maintainability and safety). Noise and vibration, electromagnetic compatibility and interface management will also be included.

As the appointed ISA, Ricardo's teams will in addition assess engineering and maintenance system safety against relevant international standards, including IEC 62278/62279/62425.

The new GTX network is expected to enter service in 2024, with lines B and C adding a further 130 km to the network by 2027.

Advanced Driver Assistance Systems for trams

Following positive test results with the Netherlands' first tram-based Advanced Driver Assistance System (ADAS), the Dutch public transport operator HTM recently announced that it will install a smart braking aid on all Avenio city trams. This detection system supports the tram driver in the prevention of collisions.

HTM contracted Ricardo to provide support in determining the best approach for implementation of the ADAS add-on, and for developing the supporting documentation. As this is the first time an ADAS feature has been used on trams in the Netherlands, there was no pre-defined implementation approach that could be used.

Ricardo developed the implementation process according to the railway industry standard EN 50126, building on its expertise in automotive sensor technology and the equivalent automotive functional safety standard, ISO 26262.

Over a one-year implementation period, during which approximately half a million kilometres were covered, it was reported that most of HTM's tram drivers who used the system adjusted easily and quickly to driving with the braking aid.

FT recognizes Ricardo for sustainability – for third successive year

In its third annual rating of the UK's top management consultancies, the Financial Times (FT) has once again identified Ricardo Energy & Environment as a leader in the area of sustainability in its UK's *Leading Management Consultants 2020* listing.

The rating for sustainability services is based on comments made by clients and peers throughout industry. Recognition by the FT in this way reinforces Ricardo's position as a leading consultancy in the environment and sustainability arena. Particular areas of growth for Ricardo within this sector over the past year include supporting the preparation and implementation of clean air zones, the development of net-zero strategies for the public and private sector organisations, and the delivery of innovative solutions in the energy and water sectors.

"On behalf of the entire Ricardo Energy & Environment team I am delighted that our company has been recognized for the third successive year as a leader in the area of sustainability," commented Ricardo Energy & Environment MD Tim Curtis. "I would like to extend our thanks to our clients involved in the Financial Times survey, as well as to all of our customers worldwide, for their continued support of and confidence in Ricardo."

Ricardo's environmental consulting business boasts a broad client base that includes major corporates, national and local governments, energy, water and waste utilities, airports and a wide range of international agencies.

GaN-based EV inverter design

Global semiconductor manufacturer Nexperia is to partner with Ricardo to produce a technology demonstrator for an EV inverter based on gallium nitride (GaN) technology.

GaN is the preferred switch for this type of application as GaN field-effect transistors allow systems to achieve greater efficiencies at lower costs, with improved thermal performance and simpler switching topologies. In automotive terms this means that the vehicle has a greater range – the major concern for anyone looking to buy an electric vehicle. GaN is now on the brink of replacing silicon carbide or silicon-based insulated-gate bipolar tranistors as the preferred technology for the traction inverters used in plug-in hybrids or full battery-electric cars.

Nexperia announced a range of AEC-Q101-approved GaN devices last year, providing automotive designers with an ever-widening portfolio of proven, reliable devices in this high-efficiency technology – an innovation which delivers the increased power density now demanded for electrification of the powertrain.

As a highly regarded global engineering consultancy which can boast of collaborations with leading high-profile brands such as McLaren and Bugatti, Ricardo was the perfect partner for Nexperia for this project.

Michael LeGoff, general manager for GaN at Nexperia, commented: "By designing our GaN devices into an inverter and trialling them through Ricardo, we will be able to better understand how a vehicle can be driven safely and reliably. We are developing a real solution that I think a lot of automotive designers will be interested in having a look at and will find extremely advantageous."

Synthetic e-fuels for sustainable shipping

A Ricardo study, commissioned by the US-based Environmental Defense Fund and focusing on Chile, highlights the enormous potential for the production of e-fuels from renewable energy for use by the shipping industry.

The report, entitled *Electrofuels for Shipping*, discusses how synthetic fuels derived from renewable energy could play an important role in decarbonizing the international shipping industry. There is a specific focus on the role that Chile might play in delivering such a low-carbon future.

Using renewable energy, hydrogen can be produced in electrolyzers by separating hydrogen atoms from water. This 'green' hydrogen can then either be used as a fuel directly or processed further to produce green ammonia or carbon-based fuels like methanol.

However, the substitution of these e-fuels for more traditional fuels is not without engineering challenges – not just in terms of propulsion, fuel handling and storage systems, but also in the protection of port staff and crew. Provided such engineering challenges are addressed, carbon-neutral e-fuels offer a sustainable alternative to the existing fossil-derived fuels used for marine applications.

The purpose of the report is to illustrate in a practical way how countries which possess large untapped renewable resources could use the energy demand from ships to unlock investment in new clean energy infrastructure.

Chile is heavily reliant on shipping for both international trade and domestic transportation. It also has one of the largest renewable energy capacities in the world, with over 1200 GW of solar potential alone. Moreover, Chile's unique geographic setting and size offer many favourable locations to install renewable infrastructure and fuel plants close to the main ports, and therefore well placed for shipping routes.

Promisingly, the report concludes that Chile is perfectly positioned to become a South American hub for clean shipping. For further information or to download a copy of the report, see: https://europe.edf.org/alternative-fuels-shipping

New leadership for innovation and software

Mike Bell has joined Ricardo plc as chief innovation officer (CINO) to spearhead the company's forward plans on future product, technology and service innovation.

Bell, who joined Ricardo in December last year, brings to the Group an extremely broad-ranging body of experience, having guided technology development initiatives across multiple sectors. These include energy and telecoms, utilities, public sector bodies and, in the automotive industry, major IT systems and Internet of Things (IoT) concepts.

Bell was recruited from Laird, where he was chief technology officer; among his previous roles was leading Jaguar Land Rover's Connected Car business, where he was responsible for driving innovation through new business models, products, services and technologies.

As Ricardo's CINO, Bell will be responsible for maintaining a wide-angle view of future technologies that are likely to impact Ricardo's group-wide business strategy and operations in the medium to long term; his expertise will be instrumental in helping define the organization's overall innovation strategy, including delivering a portfolio of innovative concepts that that cut across the boundaries of the Group's separate divisions. With the disruptive potential of digitalization, he will lead evaluation and implementation strategy for digital across the Ricardo business.

New Ricardo Software leadership

In January 2020 Kim Matenchuk joined Ricardo as the new president of the Ricardo Software business. She joins Ricardo from her former role as senior director for European sales at GE Digital, where under her tenure the business grew substantially across industrial sectors including those for automotive, food and beverages, consumer packaged goods, chemicals, and life sciences.

Prior to this, she was the strategic partner lead at Google UK, and held roles with both digital technology firm Tangozebra and the independent marketing and advertising consultancy g2 Marketing.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