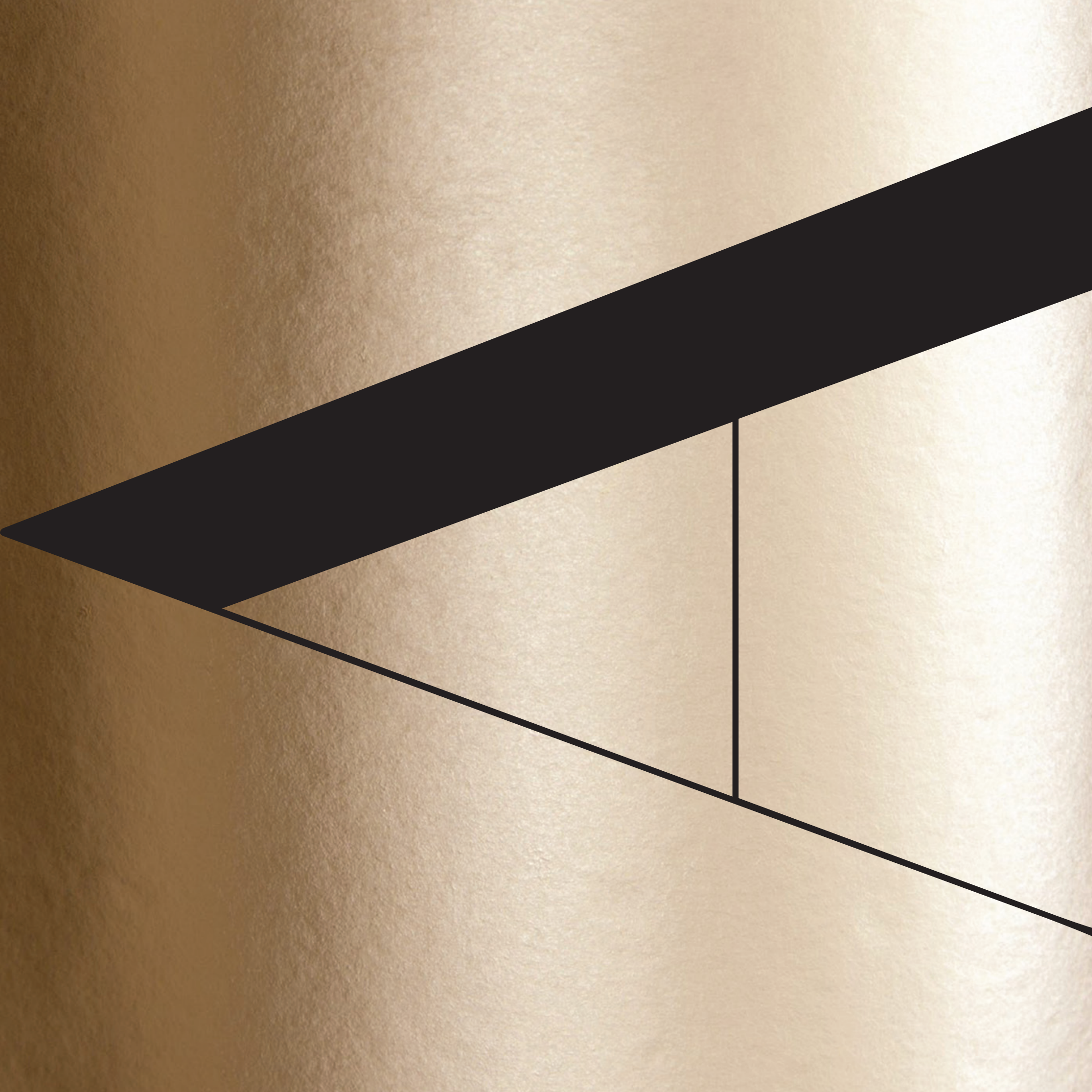


THE ADVENT OF TECHNOLOGY

THE ADVENT OF TECHNOLOGY

THE ADVENT OF TECHNOLOGY HAS REVOLUTIONISED HUMAN LIFE. FROM MODERN CONVENIENCES WE NOW TAKE FOR GRANTED LIKE THE WASHING MACHINE AND MICROWAVE, TO MORE COMPLEX DEVICES THAT WE RELY ON TO KEEP US CONNECTED, MOVE US FROM PLACE TO PLACE, AND KEEP US SAFE AND HEALTHY, TECHNOLOGY HAS COMPLETELY CHANGED OUR LIVES. IT HAS REDUCED THE EFFORT AND TIME WE TAKE TO DO THINGS AND BROUGHT ABOUT A REVOLUTION IN TRANSPORT AND COMMUNICATION.

In the past, advancements in transportation technology were mainly centred on the mechanical aspects – how to go further and faster, how to make the engine more efficient, how to ensure a smoother ride, the list went on. These days, improvements have gone beyond just the mechanical and now encompass advancements in information and data technology – all of which are needed for the smooth, effective and safe delivery of mobility services.

Four technologies have risen to the forefront of the latest transportation revolution[1].

INTERNET OF THINGS

The Internet of Things assumes that all people and items can be connected through networks. These vast connected networks could potentially influence many aspects of our daily driving:

ROUTE PLANNING Sensors in the vehicle communicate with Global Positioning System services to determine the best route, which is then displayed on a head-up display that physically directs the driver along a route.

ACCIDENT PREVENTION Sensors alert drivers to the position of other vehicles on the road and prevent collisions. The cars can even override driver controls to avoid an accident.

SAFETY A series of sensors in the seat belt can track the driver's physiological indicators and determine whether the driver is fatigued or intoxicated. If the driver fails any of the tests performed by the sensors, the vehicle becomes inoperable.

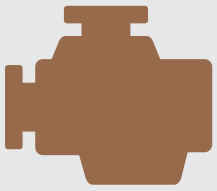
AUTONOMOUS VEHICLE TECHNOLOGY

The advent of self-driving driving cars such as the Google car and Telsa are slowly making the idea of autonomous vehicles (AVs) a reality. Some countries have already begun passing laws to regulate the technology and encourage its development. However, the safety and public acceptance of these AVs have been a question of public interest and concern. Moreover, a series of accidents in the summer of 2016 increased the debate about the safety of such vehicles.

With continued research and development, autonomous car technology will likely become a safer alternative to human drivers, with additional economic and environmental benefits. Removing human control from the vehicle will potentially help cars reach their designed fuel economy, leading to less gas consumption and reduced cost of vehicle ownership.

1 5 Advancements in Transportation Technology | Ohio University

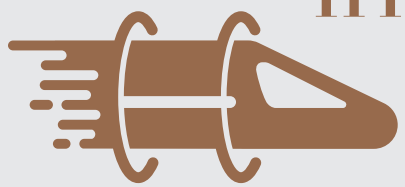
> THESE DAYS, IMPROVEMENTS HAVE GONE BEYOND JUST THE MECHANICAL AND NOW ENCOMPASS ADVANCEMENTS IN INFORMATION AND DATA TECHNOLOGY – ALL OF WHICH ARE NEEDED FOR THE SMOOTH, EFFECTIVE AND SAFE DELIVERY OF MOBILITY SERVICES.



LIGHTWEIGHT VEHICLE MATERIALS

Automobile manufacturers are under increasing pressure to deliver vehicles with high performance and excellent efficiency. Studies have shown that reducing the weight of the vehicle by as little as 10% can improve fuel economy by 6% or more.

The focus of lightweight materials research is to move away from cast iron and steel. The leading candidates to replace these metals in the near future are magnesium-aluminum alloys and carbon fiber construction. However, questions still exist about whether the materials can hold up under the forces of highway accidents, and whether manufacturers will be able to produce lightweight materials at a low enough cost for automakers.



HYPERLOOP

The most ambitious of all of the technologies changing transportation is SpaceX's Hyperloop. The concept is a pneumatic tube that uses a series of linear induction motors and compressors to propel vehicles at super-fast speeds. The first proposed Hyperloop would connect Los Angeles and San Francisco and allow passengers to complete the 350-mile trip in just more than half an hour.

Time will tell if Hyperloop's technology will be the future of long-distance travel. As an emerging technology, the initial cost is astronomical, with estimates of the first line placed at more than US$6 billion.

AS A GROUP, WE HAVE PAID CLOSE ATTENTION TO THE DEVELOPMENTS THAT HAVE BEEN TAKING PLACE ALL AROUND US. IN THE LAST FEW YEARS, WE HAVE STEPPED UP OUR INVESTMENTS IN KEY TECHNOLOGICAL AREAS THAT WILL ENSURE THAT WE REMAIN RELEVANT IN THIS NEW WORLD THAT WE LIVE AND OPERATE IN. THESE INCLUDE INVESTMENTS IN BOTH FRONT- AND BACK-END SYSTEMS AND TECHNOLOGY, ALL AIMED AT IMPROVING THE WAY WE OPERATE AS A GROUP AND SERVE OUR CUSTOMERS AND PASSENGERS. HERE, WE SHOWCASE SOME OF THESE INVESTMENTS.

AVs
REALISING THE DREAM

An investment in autonomous technology is a leap of faith. Afterall, it is still very much in its infancy stage and not without detractors. But, sometimes, such a leap is not just prudent, it is necessary.

As the world slowly moves toward autonomous technology, introducing consumer robotics and trialling autonomous cars in restricted environments, ComfortDelGro took its biggest step into the future with the establishment of a S$30 million Autonomous Vehicle Centre of Excellence (AV CoE) aimed at building up its capabilities in the operation and maintenance of these driverless vehicles.

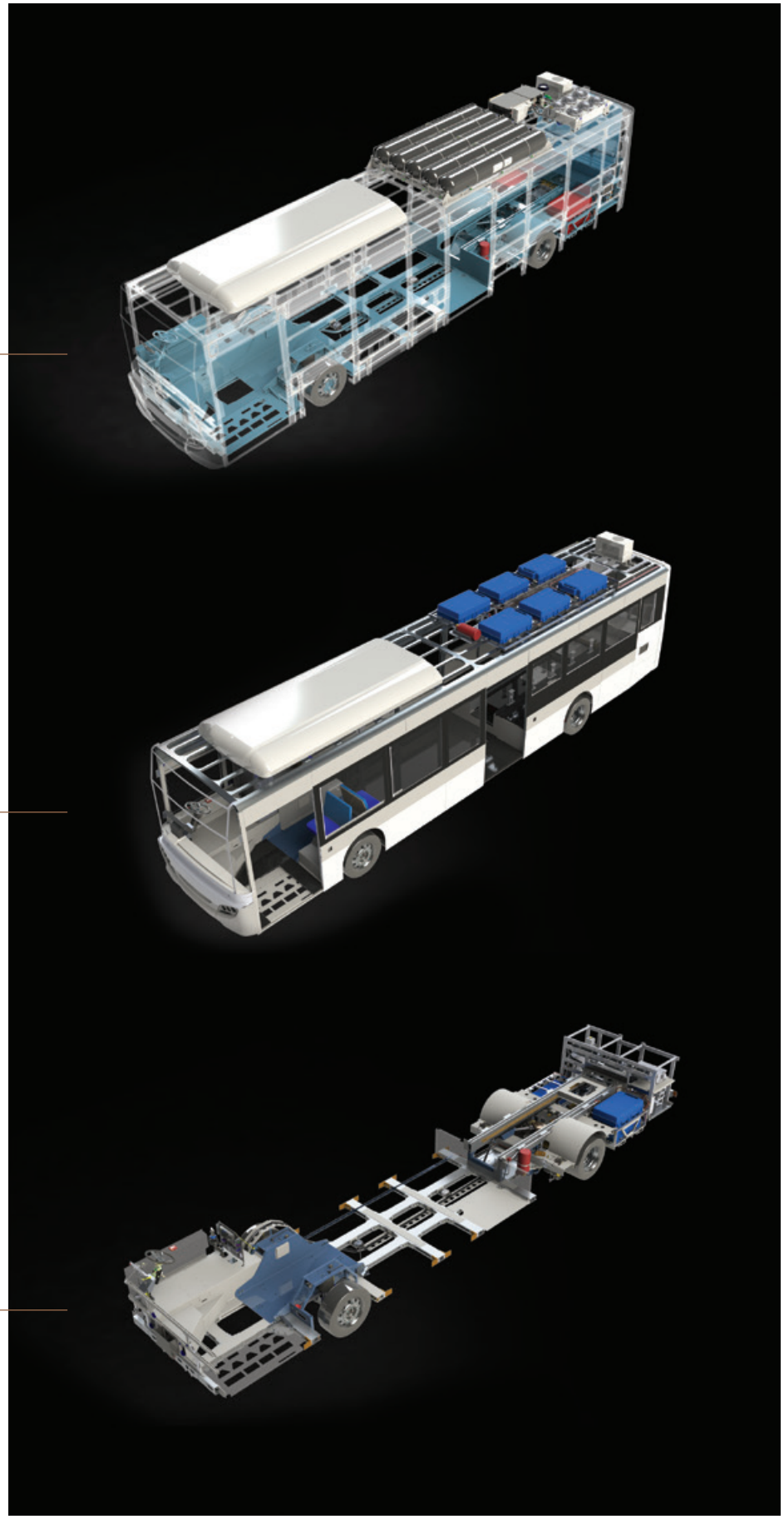
The AV CoE, which was set up through ComfortDelGro's US$100 million venture capital fund, will focus on the research and development of AV-related capabilities over the next five years. It will enable the Group to develop a technology platform to support the delivery of mobility services using AVs, with a view to deploy them commercially.

Work has already started with a Memorandum of Understanding (MoU) signed with Mobileye, an Intel Company[2], a global leader in the development of vision technology for Advanced Driver Assistance Systems (ADAS) and autonomous driving. The Company has been developing state-of-the-art technologies in support of automotive safety and autonomous driving solutions over the last two decades, with more than 100 million vehicles built to date with Mobileye's EyeQ™ technology.

Under the MoU, ComfortDelGro will leverage Mobileye's AV technology to build new skills in driverless operations, incident response processes, fleet management and maintenance. The AV CoE will also look into building a technology platform to manage AV operations that are scalable and transferable not only in Singapore, but overseas as well.

More of such tie-ups will be made over the next few years as the technology unfolds and when AV becomes a reality for the masses, ComfortDelGro will be there as a major service provider.

2 Mobileye was acquired by Intel Corporation in 2017



Hydrolight Render Component

Lightening 259kW

Lightening Chassis

LIGHTER AND MORE EFFICIENT

One critical element in which to reduce emissions and save fuel is the weight of a vehicle. Because it takes less energy to accelerate a lighter object than a heavier one, lightweight material offers the potential to increase vehicle efficiency.

The Group's bus subsidiary in the United Kingdom (UK), Metroline Limited, has been utilising lightweight materials, from glass fibre reinforced plastics to fibreboard flooring and interdecks in its Alexander Dennis Limited (ADL) and Volvo buses, for well over a decade. This has resulted in improved fuel economy for the buses, with fuel consumption figures improving by more than double from about three miles per gallon in 2008 to about seven miles per gallon in 2022.

As the Group transitions towards zero emission vehicles, the focus is also on how we can reduce vehicle weight. The utilisation of lightweight materials in zero emission buses not only enhances energy efficiency and maximises the range of the vehicles, but also helps to meet passenger loading requirements.

By 2023, Metroline will have 200 electric and hydrogen buses. These hydrogen buses are being manufactured by Wrightbus in Northern Ireland, and will incorporate aluminium wheels, lightweight saloon floors and lighter glass reinforced plastic, resulting in weight savings of up to 80kg. Metroline is also working with ADL BYD UK and Volvo MCV to make similar modifications to the next batch of electric bus orders.

Elsewhere in the UK, the Group's taxi subsidiary, Computer Cab (Liverpool), which is Liverpool's largest taxi circuit operator, also utilises lightweight materials in its new electric taxis. About 10% of its Liverpool cab fleet comprises electric taxis from the London Electric Vehicle Company, which uses bonded aluminium monocoque instead of steel in its chassis, resulting in weight savings of about 30%.

IN SINGAPORE, COMFORTDELGRO BUS' NEW FLEET OF 10 BYD AND 44 ZHONGTONG ELECTRIC BUSES COME WITH LIGHTWEIGHT MATERIALS INTEGRATED INTO ITS CHASSIS.

Down Under, ComfortDelGro Corporation Australia is awaiting delivery of two hydrogen fuel cell electric buses which are scheduled to start serving customers from early-2024.

These two buses come with bolted aluminium chassis supplied by Australian-based manufacturer, Aluminium Revolutionary Chassis Company (ARCC). Compared to other zero-emission buses with traditional steel chassis, the ARCC Hydrolight Viking Fuel Cell Electric Bus weighs about 2,000kg lighter.

In Singapore, ComfortDelGro Bus' new fleet of 10 BYD and 44 Zhongtong electric buses come with lightweight materials integrated into its chassis.

The BYD buses are built with aluminium body frames and panelling which reduces the weight of the bus by about 300kg. The Zhongtong buses on the other hand, utilise FRPlus® Honeycomb Flooring developed by Qiyi Technology. FRPlus® Honeycomb Flooring, which is made up of thermoplastic polypropylene, comprises multiple vertical and horizontal layers with various continuous fibre reinforcement layers. The usage of FRPlus® Honeycomb Flooring on the Zhongtong buses helps to shave about 250kg off its weight.

It's not just buses and taxis that are going lightweight. Our concrete trucks are also going the "feather route"!

In China, the Group operates 40 GAC Hino 8x4 lightweight concrete trucks under its joint venture company, Guangzhou Guangxi ComfortDelGro Logistics Co., Ltd. The engines of these trucks are compact and integrate lightweight design by utilising an overhead camshaft and rear gear train. The trucks also feature strong lightweight frame rails and aluminium alloy fuel tanks which all add up to weight savings of over 400kg.

WHEN PREVENTIVE MAINTENANCE BECOMES AN EXACT SCIENCE

The North East Line (NEL) in Singapore is the world's first fully-automated underground rail line. When it was launched for revenue service in 2003, it was also the first Mass Rapid Transit system in the country to use the Overhead Catenary System (OCS) to deliver traction power to its trains. Any disruption to this system had massive repercussions, which is why a lot of time, money and effort went into maintaining and upkeeping it.

At the start, the maintenance of the OCS consisted of schedule-based inspections and measurements, and corrective replacement of wires or components. Maintenance staff carried out these tasks manually during off-service engineering hours in the dead of night. It was not an easy job and involved the installation of a 3m high scaffold for staff to climb to manually inspect and take measurements.

Besides being time-consuming and unsafe, there was the added issue of data accuracy since measurements were taken manually.

The situation wasn't ideal and prompted SBS Transit to implement two condition monitoring systems - the Catenary Eye (Cat Eye) in 2015 and OCS Video Monitoring System (OVMS) in 2017 – to automate the work processes in measurement, inspection and early fault detection for the OCS. team. The two systems made use of technologies in high-speed image capturing, laser scanning, image recognition and thermography for data collection, 3G/4G wireless communication for data transfer and real-time notifications to the maintenance data management, data analysis, fault detection and fault reporting.

The Cat Eye System specifically conducts measurement and data analysis on the OCS contact wires thickness, height and stagger while the OVMS detects supporting structures that are misaligned, have missing components or foreign objects.

The implementation of the two systems posed numerous challenges to the SBS Transit team then due to system and technology constraints. For example, the engineering trains had to be modified to accommodate the extra space and electrical power requirements of the Cat Eye and OVMS system. The lack of access to the Global Positioning System because the rail network was located underground also proved to be a major hurdle. To overcome this, SBS Transit redesigned the location identifying module using tachometers and laser detectors.

But once the systems were up, it was clear that the benefits far outweighed the costs involved. The team witnessed a drastic improvement in data measurement accuracy as we are able to measure the OCS with a better tolerance of +/- 5mm as opposed to +/- 10mm using conventional methods. Not only that, the Cat Eye System eliminated human error from manual measurements. There was also a dramatic improvement in productivity. Conventional inspection methods requires 924 man-hours a year, while the Cat Eye performed the same task with a much higher degree of accuracy with just 12 man-hours a year.

The system also logged a tremendous amount of data and footage which could be used for trending and early fault detection. The software also analysed the massive amounts of data in just one hour – compared to the two weeks it would have taken a team of data engineers.

The new systems greatly enhanced SBS Transit's capabilities in monitoring the conditions of OCS and detection of faults. OCS engineers are able to plan for corrective works more effectively to rectify potential problems before they develop into a fault failing the OCS system disrupting train service. They helped propel SBS Transit's maintenance regime into the 21st century, allowing it to evolve from a schedule-based maintenance to a more dynamic condition based maintenance to improve overall system reliability whilst reducing costs.


71025
SBS Transit
SBS Transit

COMBATING ROAD FATIGUE – THE SCIENTIFIC WAY

With our drivers on the roads traversing thousands of miles every day, road fatigue has become a very real and serious problem. This is why the Group has invested significantly in the research of this subject – to ensure the safety of our drivers, passengers and fellow road users.

With the advent of technology, combating driver fatigue has become an exact science – and no longer left to chance. We showcase two examples of just how our operations in Australia and Singapore utilise state-of-the-art techniques to minimise the incidence of road fatigue.

IN AUSTRALIA

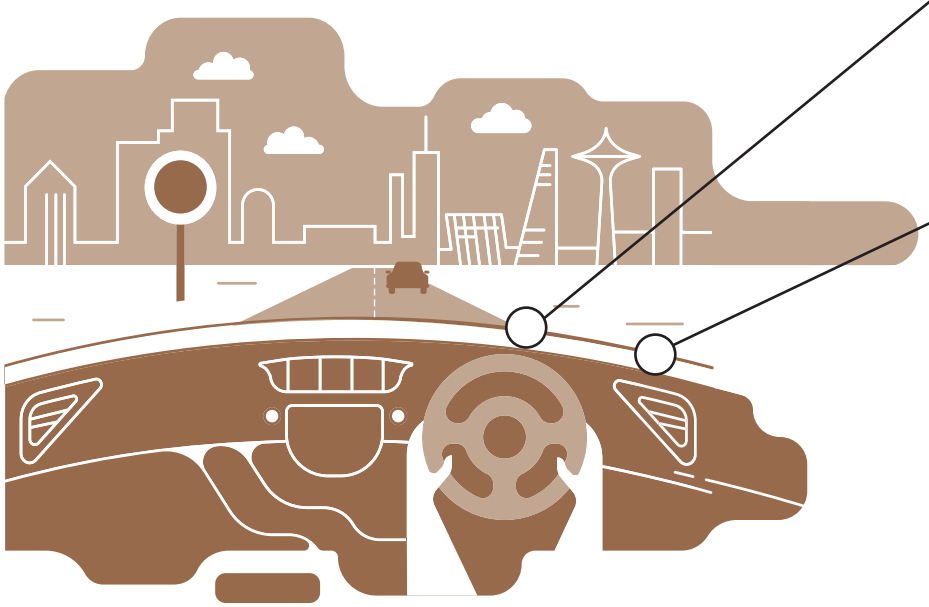
ComfortDelGro Corporation Australia's (CDC) wholly-owned subsidiary CDC NSW implemented the Guardian Alert System which employs complex algorithms and artificial intelligence to monitor driver's facial expressions, eyes and head movements to determine fatigue (microsleep and drowsiness) and distraction. If the driver's eyes are closed for longer than the pre-programmed interval (currently 1.5 seconds) – or they look away from the road for an extended period (4 seconds currently) when the bus is on the move – an audio alert sounds and a vibration is transmitted to the bus driver's seat to alert the driver. If warranted, CDC then follows a series of protocols to immediately replace the driver on-road.

The Guardian Alert System initially started as a trial in 2020 for the Sydney Metro Bus Service Contract (SMBSC) Region 4 on seven buses. Based on the success of its trial, it has now been rolled out to 76 buses or 7% of the fleet across all CDC NSW Regions which cover SMBSC Regions 4 and 14, Outer Metro Hunter Valley and Blue Mountain contract regions. This enables each driver to be monitored on a fortnightly basis, providing a significant uplift in its approach to monitoring driver fitness for duty.

In conjunction with implementing the system, CDC has instigated a wellness programme and every driver who triggers the system is required to undertake a medical check and wellness/lifestyle assessment.

It is a proactive tool demonstrating corporate risk mitigation, control, and measurement in accordance with the National Heavy Vehicle Regulation through Australia and addressing risk within other ISO standards and local regulatory requirements.

Importantly, it solidifies CDC's proactive approach towards drivers' wellbeing, i.e., identifying potential health issues such as sleep apnea within its workforce and enables early intervention and prevention.



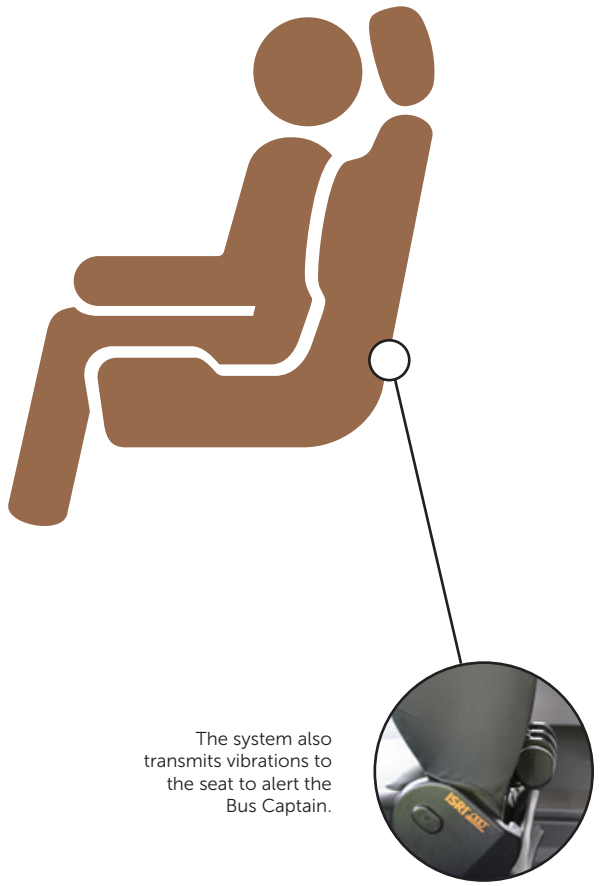
Goldeneye Monitor Camera
The Goldeneye Anti-Fatique System uses a monitor camera to detect signs of fatigue and distractions in Bus Captains.

T-Watch Display
Upon detection, the system automatically sends out signals with visual alerts displayed on the T-watch while audio beeps are emitted.

IN SINGAPORE

SBS Transit uses the Goldeneye Anti-Fatigue System – a driver auxiliary warning system that uses machine and facial vision technology to detect signs of fatigue and distraction and provides real-time feedback through audio, visual and haptic alerts to Bus Captains. This helps Bus Captains to keep alert and be safer drivers.

- Goldeneye enables interchange management to intervene and counsel Bus Captains with frequent fatigue/distraction.
- Goldeneye generates data based on Bus Captains' behaviour which is collected in SBS Transit's central server. The system automatically churns out a weekly report to alert the interchange management of Bus Captains who were detected with fatigue or distracted behaviour.
- With the report, Interchange Management can retrieve video footage from the system to view and from there, intervene and counsel Bus Captains.
- A trial was conducted in January 2019 with 30 buses to assess its effectiveness. Another trial was conducted between September and February 2022 to assess the post intervention function, which is an add-on to the system. The trial was a success. As at October 2022, 7% or 253 buses are equipped with the Fatigue Management System.



The system also transmits vibrations to the seat to alert the Bus Captain.

BEYOND INVESTMENTS IN TRANSPORTATION-RELATED TECHNOLOGIES, COMFORTDELGRO HAS ALSO BEEN SCALING UP ITS OPERATIONAL AND SERVICE EXCELLENCE THROUGH TECHNOLOGICAL IMPROVEMENTS. BIG OR SMALL, SIMPLE OR COMPLEX, THESE INVESTMENTS HAVE BEEN MADE WITH THE SOLE PURPOSE OF IMPROVING THE WAY WE DELIVER OUR SERVICES, AND ULTIMATELY, TO IMPROVE THE LIVES OF ALL AROUND US.

HERCULES NOT NEEDED

The Group's technical testing subsidiary, Setsco Services (SETSCO), conducts tests for no less than 1.5 million samples every year on a wide range of products for various sectors of the economy including the manufacturing, construction and oil and gas industries. One of these is the "Cube Test" which is critical in the analysis of concrete for use in the construction industry. The test essentially determines the compressive strength of each block of concrete and serves as a quality control check to ensure that the material used is strong enough for the requirements of the construction industry.

On average, SETSCO tested approximately 2,200 concrete cubes per day (or 560,000 cubes per year) and utilised eight compression machines. It was a very labourious task, done by a team of no less than eight operators, as each concrete block had to be manually lifted onto the machine for the test to be conducted. The block then had to be manually removed after each test. To call it back-breaking was an understatement.

SETSCO decided something had to be done to not only prevent its staff from developing hernias, but also improve productivity.

So in 2013, a team was formed to find a solution to this Herculean task. After two years, a new automated cube testing system costing S$880,000 was rolled out. It required only two staff to load and feed the cubes via the conveyor belt to the eight compression machines which were in turn operated by four robots.

To further improve operational efficiency, a conveyor belt with a discharge arm was installed to dispose the tested/crashed cubes directly into the disposal tank without the need for secondary handling.

The process was also digitised so that all cubes were identified with a barcode sticker which enabled the robot to pick, scan, weigh, load and test the cubes. The cube test results were then immediately sent to clients and consultants for immediate reference. This specially designed system was patented by SETSCO on 30 December 2015 – a true milestone in our development as an innovative testing centre.

When SETSCO moved from its old Teban Gardens premise to the new one in Bukit Batok in September 2021, the system was further upgraded with new features including a "vision-controlled" robotic arm which is now able to pick cubes up automatically from the tanks and place them onto the new and more durable shutter system – with absolutely no human intervention at all!

LEVELLING UP THE WORKSHOP EXPERIENCE WITH TECHNOLOGY

As a business that has its roots in the advancement of technology and engineering, it is no surprise that ComfortDelGro Engineering (CDGE) has been one of the Group's subsidiaries that has taken concrete steps to enhance its work processes and productivity with technology.

In November 2020, CDGE launched the CDGE App, Singapore's first end-to-end workshop app that aims to make car repair and maintenance that much simpler and convenient for its customers. The CDGE App not only enables vehicle owners to book an appointment and monitor the progress of all repairs, but to also secure servicing quotations in real-time, and even "shop" for car care-related products and services.

Prior to the App, all updates and quotations were sent through phone calls, emails or WhatsApp, often than not platforms that demand extraneous attention of both workshop staff and customers.

When all the work on the vehicle is done, customers will be able to receive via the CDGE App a push notification when their cars are ready for collection, enabling them to better plan their schedules while their vehicles are in the workshop.

Mr Kelvin Sim, 49, a customer for the past eight years, was one of the earliest users of the CDGE App when it was launched. He said: "The CDGE App has enabled me to easily book my servicing and car-grooming appointments as well as to conveniently monitor my car maintenance history and what needs to be done next to ensure it remains in tip-top condition.

"Previously, I have to call the service centre to book appointments, check my service history and service package balance which is time-consuming but now I can do all that and more, real-time via the App!" he added.

The CDGE App is not the only innovation to come out of CDGE. It had in April 2020, also developed a complementary App, called the Smart Workshop Digitalisation System App or SWorDS, for short, to enable its frontline staff to digitally "check in" the car when the customer sends it in for servicing or maintenance.

Photographs of the car in its original state are taken using a 10-inch touchscreen tablet by the workshop supervisor to ensure a proper handing over process from the driver to the workshop. The car is then assigned to an available technician, who receives the job in real-time via a Company-issued mobile phone.

Previously, the entire checking in process was done on paper where forms had to be filled up, and the technician receiving the assignments had to use physical job cards. But, with SWorDs, depending on the servicing and maintenance package that the customer has chosen, the technician assigned to the job can refer to the App for a comprehensive list of areas to check on.

Should there be other repair works that are needed, the technician is also able to quickly inform the supervisor, and then through the CDGE App, seamlessly push out a comprehensive quotation of the repairs to the customer. Once the customer accepts the quotation through the CDGE App, the technician will be able to carry out the repairs.

Mr Ang Soo Hock, Chief Executive Officer of CDGE, said: "Car repair is a very manual process but the communication with our customers doesn't have to be. We felt that by leveraging on technology, we would be able to improve the customer experience, make work processes more efficient and our people more productive. Going digital is also enabling us to go green.

"For example, our staff can now do away with the paper trail such as the old job cards. They can now send quotations for repairs digitally to customers; assign jobs without referring to a paper roster; and carry out servicing according to a ready checklist that is available in the App."

Mr Muhammad Firdaus, 33, a Lead Customer Care Specialist Officer with CDGE for the last nine years, welcomed the transition to SWorDs. The frontliner who is the first point of contact for cabbies, private-hire car drivers and the servicing crew, said: "The good thing about having the SWorDs is the chance to go entirely paperless. The biggest difference that it has brought to my work – faster processing time for jobs as we operate entirely on the digital platform, quick turnaround time between us and the customers, and an interactive platform for me to feedback on the vehicle that I am working on in real-time.

"Where it used to take 30 minutes due to the paperwork, it takes me only 10 minutes via SWorDS to get a customer registered and briefed on the necessary repair and maintenance works to be done on his or her vehicle. It is really more efficient," said Mr Firdaus.

And it is not just members of the public who have benefited from the advent of the App, ComfortDelGro cabbies also enjoy the same benefits when their taxis are due for preventive maintenance checks.

Cabby Ang Beng Ann, 63, who has been plying the roads as a cabby for more than 30 years was thankful for the convenience that the CDGE App has brought. Said Cabby Ang: "The CDGE App is very easy to navigate. With it, I can now access much needed maintenance and repair services in a much timelier fashion. Where in the past, we had to fill up hardcopy job cards with details on repair needs, now we can simply convey our requirements to a Service Advisor who will input them into the SWorDs App and get a real-time response from the technicians stationed at the workshops.

"The App also sets up and reminds me of my upcoming servicing and maintenance appointments at the workshops, so that shaves off unnecessary waiting time. It also notifies me on the time needed to complete all the necessary maintenance works. These features allow me to better manage my schedule and time," added Cabby Ang.

IN NOVEMBER 2020, CDGE LAUNCHED THE CDGE APP, SINGAPORE'S FIRST END-TO-END WORKSHOP APP THAT AIMS TO MAKE CAR REPAIR AND MAINTENANCE THAT MUCH SIMPLER AND CONVENIENT FOR ITS CUSTOMERS.