Automotive **Engineer**

Technical Update

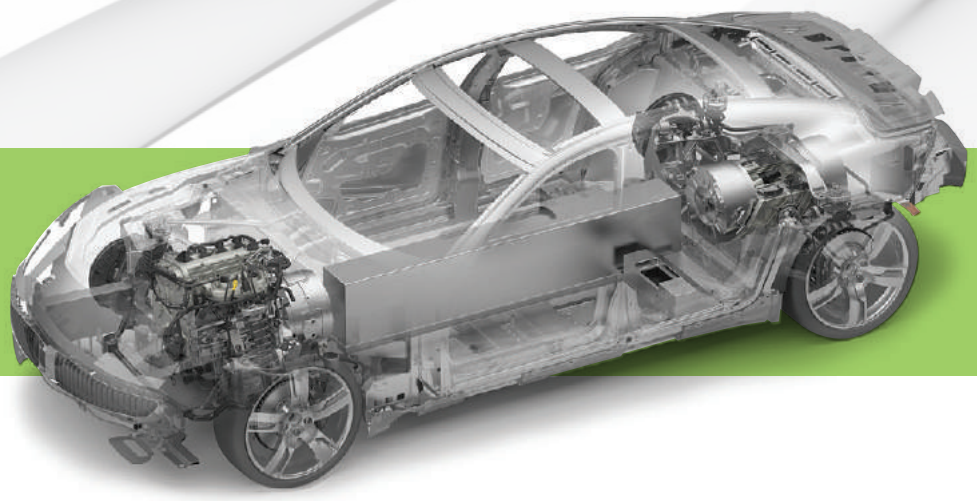
MAY 2013

Welcome to the first issue of the Automotive Engineer Technical Update for Certificated Automotive Engineers (CAE) and Advanced Automotive Engineers (AAE) members of the IMI.

We are delighted to provide these exclusive updates to you from Andrew Marsh of Auto Industry Insider (www.autoindustryinsider.com).

Topics will include emerging technologies and how the significant changes in the makeup of vehicles all impact on how the modern vehicle works, and how it needs to be maintained, serviced and repaired.

We have included some questions at the end of the update to allow for reflective learning, which can be used towards your Professional Register CPD target. We have also noted 'further learning' topics and listed specific CPD courses which will help enrich your knowledge as we move forward.



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independent news & technical information for the auto industry

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Automotive technology explosion, telematics… and how to keep up

In this issue, we'll explore changes in vehicle ownership, how vehicles are and will be ever-more reliant on telemetry, how the simple engine or diesel engine choice is expanding rapidly, and opportunities for the aftermarket as a result of vehicle manufacturers operating in a global economy. The overriding theme is how and where does the aftermarket fit in? Let's find out…

1. **Who wants to own a car anyway?**
2. **Connected technology**
3. **Powertrain engineering diversity**
4. **Body engineering diversity**
5. **Changes in the aftermarket sector - what does this mean for me?**

Who wants to own a **car** anyway?

A new global phenomenon has arisen - the biggest social change since the industrial revolution has been underway not only in 'emerging' economies but is also evident in the UK - the mega city. Defined as having more than 10 million citizens, Greater London already qualifies, and Tokyo, for the time being, remains the world's biggest city with more than 20 million inhabitants. Let's consider how many large cities have been created between 2002 and 2012:

	2002	2012
Cities with 5 million or fewer inhabitants	15	24
Cities with between 5 million and 8 million inhabitants	8	12
Cities with more than 10 million inhabitants	16	21

Source: United Nations

In the UK we could consider the expansion and merging of cities is strategically underway already - Coventry / Birmingham, Liverpool / Manchester / Sheffield and even Glasgow / Edinburgh. With increased population density, it is easier to provide more frequent public transport services and so reduced reliance on the car. Add to this mix significantly increased operational costs (fuel, parking, and even city access charges) and the private car will become less competitive with other means of transport for regular commuting in urban areas.

Vehicle manufacturers are very aware of this trend and worried by research which suggests the next generation of drivers are more excited about smart phones or apps than cars. The combination of the private car perhaps losing its emotional appeal along with competitive alternatives for regular commuter runs, required fresh thinking about the future. Added to that the desire by many nations to reduce dependency on imported oil, and the business model that built 80 million vehicles around the world in 2012 – forecast to rise to 100 million a year by 2017 – is well and truly challenged.

The answer from most vehicle manufacturers has been to move into short-term vehicle hire by establishing schemes with vehicles parked around city locations available for hire by the minute. The objective is to offer on-demand transport for essential additional journeys through to traditional car hire for longer trips. These schemes test a number of different aspects, such as real-time billing (to enable charges to alter for traffic jams and moving traffic), remote vehicle condition monitoring and remote access for clients. Such schemes are now being piloted by major hire companies too – this is the long term vision of the future, selling and operating cars in some of the most densely populated places on earth.

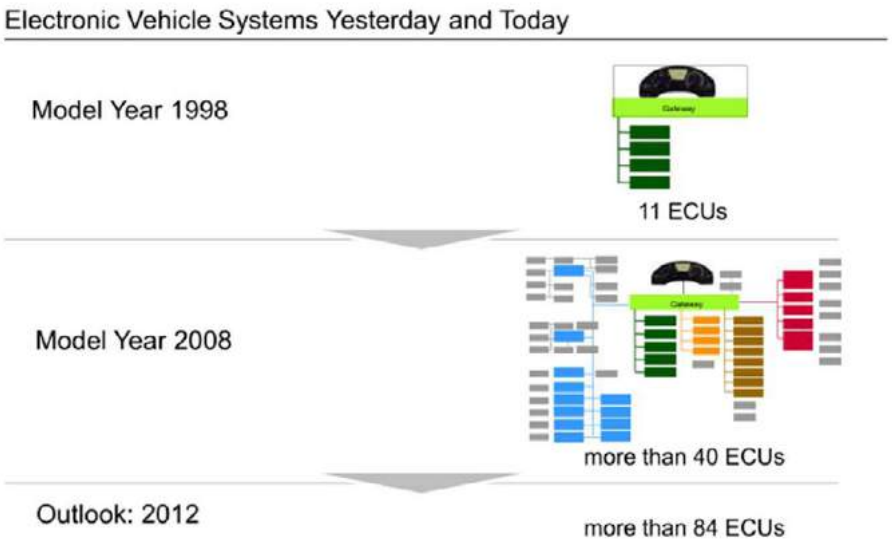
The effect on car sales and ownership will be profound, with a shift from purchase towards lease and the prospect of fewer vehicles in total by around 2030, assuming public transport manages to continue to offer a viable alternative to the private car for larger cities. That will affect the nature of the service support, with fewer dealerships but more intensive on-demand repairs to support the hire fleet. Naturally, for those who live away from major conurbations, vehicle usage will be much as it is today, although even more expensive.

Car, smart phone or App? For people surveyed in the USA, Europe and China between the ages of 15 and 17 the answer was... not the car. This is the first time prospective drivers do not see the car as an overriding priority, and a reflection of global connectivity that the trend can be found in so many diverse economies.

Pay as you go – not just for road tolls, or insurance, but whole vehicle use.© Volkswagen AG

Connected technology

The core principle of connected technology is getting previously isolated devices to work together. For many years we have seen the migration of vehicle electrical systems from wires for every single device towards a super high-speed data bus. In this system, not only power supplied but also control over every single device in the vehicle is hooked up to the same collection of wires. The result has been a revolution in electrical and electronic diagnostics.

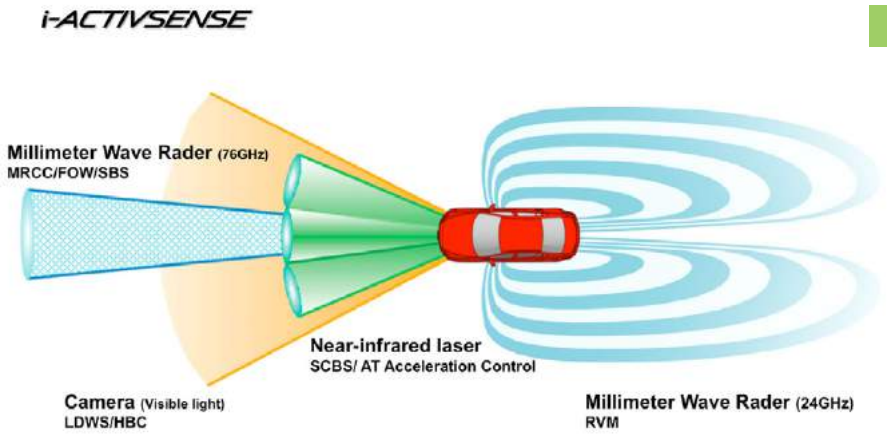


The number of electronic control module numbers has increased from 11 in the Volkswagen Golf IV through to 84 in the latest Golf VII. This has caused a radical overhaul of diagnostic systems with greater dependency on internet- based support services. The latest Volkswagen Golf VII electronic system is also used for the new Audi A3, Seat Leon, Skoda Octavia...and many more to come.

However, at the same time the communication revolution got underway so the spread of electronics inside cars also increased dramatically in recent years. Consider now all cars have ABS, more and more in the UK market have electronic stability control (ESC), electronic throttle control is almost universal, most new cars now have at least four airbags and nearly all have some form of climate control system, plus electrically powered power assisted steering (ePAS). The effect is that diagnostic systems are struggling to keep up, as the number of additional systems, as well as their sophistication, matched and then surpassed the increased diagnostics capability. The result has been to centralise services so that the ever-increasing amount of technical information can be kept up to date easily, rather than issuing endless updates via books, CDs or DVDs. The solution? Telematics.

What exactly is telematics? It is the ability of the vehicle to receive and send data to a remote device, usually via the mobile telephone network. Within that is a whole new world, combining the data of satellite navigation with other remote services and administered within the vehicle by a high-speed data system. The result is a vehicle that can 'talk' as much to the owner as it can to other businesses, from insurance through to replacement tyres, windscreen replacement, event booking services or even ..... servicing agents.

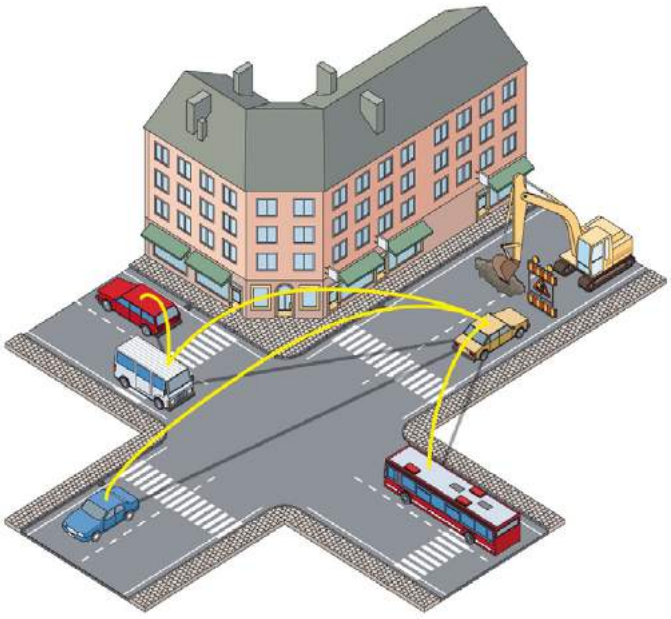
The addition of telematics technology has really opened up linking so many services to provide new combinations. When we consider the mandated fitment of ABS and ESC combined with the mass market adoption of ePAS, the building blocks for vehicles that can brake and / or steer by themselves already exist - from the smallest to largest road vehicles. Once the addition of sensors to scan for obstacles ahead, to the side or behind a vehicle are added, the next step is almost inevitable – driverless cars !



A typical array of sensors shown here on the Mazda6. The 76 GHz electromagnetic wave 'radio' sensor at the front has an ability to detect obstacles up to 200m ahead of the car, whilst the LiDAR sensor measures with greater accuracy in the sub 10m range. The single camera tracks those obstacles and classifies them from a library of around 1300 profiles. The broader spread but lower range RADAR modules at the back scan for approaching vehicles.

Indeed sensor technology is also evolving rapidly. Current 'state-of-the-art' systems have a camera to classify objects from more than 1,000 profiles (dimensions and rate of change of size relative to the closing speed), a short range infrared laser based 'Light Detection And Ranging' (LiDAR) sensor to measure up to 10m ahead of the vehicle and a 'Radio Detection and Ranging' (RADAR) sensor to measure up to 100m ahead of the vehicle. Both the RADAR and LiDAR sensors rely on the Doppler effect to detect and measure the distance to other objects whilst the vehicle is moving. Already, the RADAR sensor could be replaced by stereo camera technology, whilst RADAR sensors can now measure up to 200m ahead (introduced on the new Mazda6 in 2013).

The main power of integrating so many services will be to ensure increased safety for occupants as well as pedestrians, whilst optimising traffic flow in congested areas. A pipe dream? It's already underway.



Telematics enables vehicles equipped with such systems to communicate with each other, so alerting drivers about possible danger and preventing collisions.

Powertrain engineering diversity

The progress made in providing reduced fuel consumption, increased occupant safety and ever- improving comfort has been made possible by combining more diverse solutions into mass-produced vehicles than ever before. In order to meet CO2 emission legislation for 2012 through to 2015 (phase 1), and with phase 2 due to start in 2020, vehicle manufacturers are producing more diverse solutions within their own model ranges than ever before.

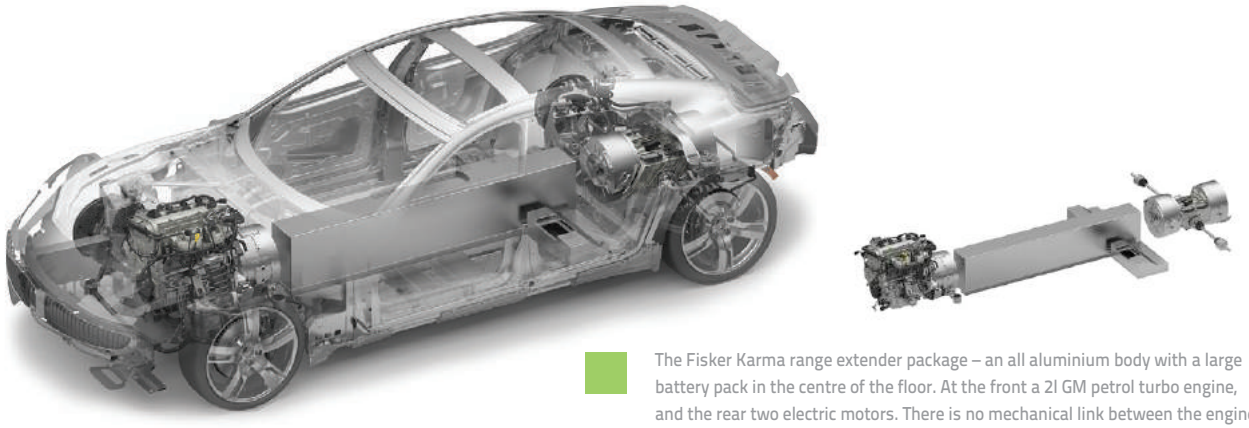
By 2020, the powertrain coverage in the UK will be:

- Diesel / gasoline internal combustion engine with automatic stop during idling ('StopStart'): The simplest and cheapest mass market method of reducing CO2 emissions, which, combined with turbo charging and reduced engine capacity, produces the new mainstream power source. Transmissions will be split evenly between manual, automated manual and automatic. The combined solution will cover 70% of new car sales.

- Diesel / gasoline internal combustion engine with hybrid - typically adds a 1 kWh battery with full charge / discharge rate control on-board the vehicle. This will enable larger cars (Mondeo / Insignia) to compete with the same small engines used by smaller models and deliver the same CO2 emission levels. The additional system cost and package intrusion will limit all applications to around 25% of all new car sales.

- Diesel / gasoline internal combustion engine with plug-in hybrid. Typically an even bigger traction battery, between 5 and 8 kWh. The cost of the traction battery will elevate the overall vehicle cost, leaving this as the preferred solution for SUVs and luxury / sports cars. This solution will cover up to 5% of all new car sales.

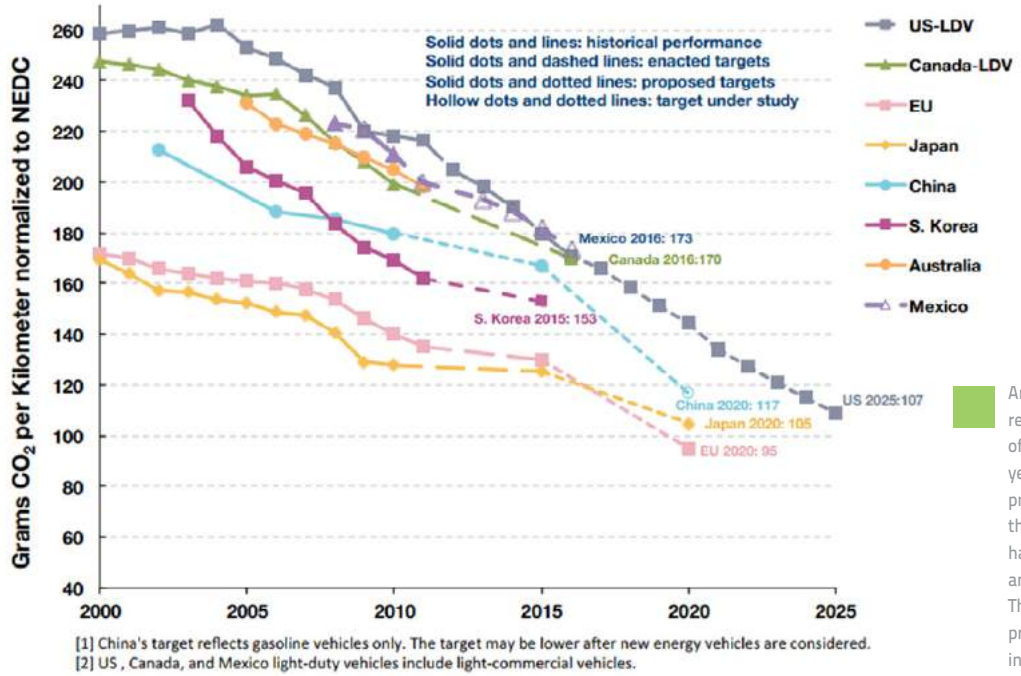
- Range extender with plug-in. This solution needs a traction battery of 22 kWh and upwards, which will be around one third of the vehicle build cost. This price will remain high as better battery technology supersedes existing technology to improve range as well as charging time. Due to the relatively high system cost, this solution will cover no more than 2% of the new car market in the UK.



The Fisker Karma range extender package – an all aluminium body with a large battery pack in the centre of the floor. At the front a 2l GM petrol turbo engine, and the rear two electric motors. There is no mechanical link between the engine and the motors.

Pure electric cars – these need several step changes in battery performance as well as being able to store more energy in a given volume ('energy density') before they come into their own. It is likely hydrogen fuel cell or internal combustion range extender packages will eclipse this segment until the energy storage revolution arrives, so for passenger cars the stumbling block will remain paying twice the price for half the product, compared to the mass market solution. Overall, new car sales are unlikely to exceed 1%

However, pure EV vans will be able to operate in all areas of all cities around the clock, regardless of Curfew, and are less sensitive to purchase price since they are business tools. Could that lead to 10% of all LCV sales in the UK being pure electric vehicles?



Amazing progress – the reduction of CO2 as an average of all new cars produced in each year from 2000 onwards, projected to 2025. Right across the world the CO2 emissions have fallen by 25% since 2010 and forecast to fall 50% by 2025. This is the legislation driven progress that has led directly to increased powertrain diversity.

Body engineering **diversity**

For more than a decade the vehicle body has been transformed by the use of a greater array of materials in a single structure than ever before. This manufacturing revolution has allowed the weight of a modern vehicle body structure to be cut by up to 100kg, and even more for larger vehicles. This weight reduction has not been at the expense of safety – rather, safety for occupants as well as pedestrians has also been improved. The capability to put so many different materials together into a single vehicle structure will be used to a greater degree in the future.

- Steel alloys remain the most common vehicle construction material, because it is relatively inexpensive, has huge capacity to absorb impact loads and can be recycled relatively easily. Corrosion protection systems have improved so much it is quite rare to rust on vehicles even 10 years old.
- However, to get more from less requires using higher strength steels, which are either tempered during the stamping process or during the manufacturing paint process (industrial ovens run at around 160°C, whereas aftermarket paint ovens run at around 120°C – so do not cause the same tempering process). The resulting strength ranges up to six times that of mild steel, and new generations of steel alloy are set to raise this towards 10 times the strength of mild steel. Such ultra-high strength steel alloys are used for key structural applications only.
- Addition of bonding agents to spot welded seams allows greater joint strength, and the potential to reduce the number of spot welds on the part of the vehicle manufacturer. Spot welds are a source of CO2 emissions which the vehicle manufacturer will be taxed on, so reducing or eliminating spot welds is desirable to reduce their tax liability.
- Aluminium alloy has the ability to be stamped, extruded, forged or cast, and vehicle structures use a combination of these manufacturing techniques. The material lends itself to bonded joints in that traditional spot welding is rather difficult, and bonding weighs less.
- Pure aluminium alloy structures remain rare, whereas selective use of aluminium for bonnet or door skins is becoming more common. Recyclability is easier than for steel, but the total energy consumption for the raw as well as recycled material is greater than for steel.
- Magnesium alloy could be used in sheet form to deliver even greater weight savings than aluminium, but the mass market manufacturing capability does not exist currently. So most applications are for castings, where weight savings can be made compared to steel, aluminium or plastic.
- Fibre reinforced plastics are gaining traction for selective structural applications in mass market cars, especially as the price of carbon fibre continues to fall. First mass market applications of low cost carbon fibre reinforced plastic is expected by 2015.

There will be continued segregation of technology, for example, aluminium alloy for luxury vehicles (lower investment costs, market perception of high technology) or carbon fibre reinforced plastics for high end sports cars (low investment / tooling costs, market perception driven by sport). Vehicles engineered with large tooling budgets will deploy an array of materials – the right material selected for the right job – and that will be typical of mass market cars.

The big news is that by 2020 at least one mainstream mass market vehicle body shell will be fully bonded together by the selective use of different steel alloys along with aluminium alloy, magnesium alloy and fibre reinforced plastics - all in the name of reduced vehicle mass, driven by offsetting improved safety as much as reduced vehicle emissions.

Changes in the aftermarket sector - **what does this mean for me?**

The automotive aftermarket faces periods of huge change over the next decade, and that means accepting that the status quo will limit new business as well as personal opportunities. The essential points from this article are:

- Car ownership will be transformed, so there will be an expansion in fleet hire provision at the expense of conventional ownership or even fleet purchase. That will require reactive service support and those services will be in direct competition from specialists because of telematics.
- Telematics will put together more service providers inside the vehicle than ever before. Those who are not part of the telematics information flow will simply not get work. This is more important for businesses rather than individuals, but this trend will take a full decade to reach the majority of the potential market. This trend is underway, so this is a great time to learn about such systems and get in on the 'ground floor'.
- There will be a short-term increase of diverse alternative powertrains which will last for around a decade, leading to many alternatives appearing even during the lifetime of a model range. A good case in point were the battery and power controller upgrades in the Honda Insight2, Honda CR-Z and the Nissan Leaf – all giving better range and reduced cost, whilst appearing externally to be almost unchanged. This will be a challenge for the aftermarket, since it will have to support every single variation of powertrain whether it sold by the thousand or just a few hundred units.
- Body engineering continues to evolve from the revolution that occured in the past decade, with the prospect of even greater material diversity as well as new ways of joining load bearing panels. That is set to have a very profound impact on the collision repair business, in that it will lead to a temperature controlled environment as well as additional training needs.

Quite simply, this is a massive period of change and that means fantastic opportunities to support this array of ever changing product, even if users may not own the car. The key points are to recognise electronics will dominate techonolgy for the next 20 years or so, that every single iteration will be in use for 10 years or more, and that the only way to keep up is with education, i.e. continuing professional development (CPD) in whichever technical field and associated role you work in.

Questions:

1. How many people live in a city defined by the United Nations as a 'mega-city'?
2. Which cities inside England, Wales, Northern Ireland and Scotland are big enough to qualify?
3. Which major conurbations in the UK could also be called 'mega-cities'?
4. How many ECUs might a mass market family car have currently?
5. What is telematics?
6. What type of sensors are used to detect obstacles in front of the vehicle?
7. How many types of hybrid are there (open question)?
8. Why do vehicle manufacturers produce such a variety of powertrains?
9. What is the EU CO2 emission targets for 2015 and 2020?
10. How are higher strength steel alloys tempered?
11. Is magnesium alloy available in sheet form for stamping?

Logging **CPD**:

Don't forget that these technical updates count towards your CPD target. To log CPD, simply visit **www.theimi.org.uk/mycpd**, and you will be taken to the CPD portal.

You can claim a CPD credit by reading this update, considering the questions above and updating your CPD record. In order to gain additional CPD points, you'll need to demonstrate how this piece of learning has had an impact on your behaviour and /or your working practices.

Related **CPD**:

Courses: if viewing online, click on the title for more information

- **Mercedes-Benz Comfort and Telematic Systems**
  Gives delegates an overview of the latest comfort and telematic systems used in Mercedes-Benz passenger cars.
- **Engine Management Systems and Dyno Tuning in Theory and Practice**
  Ideal for those seeking to enhance their knowledge of engine and ECU operation.
- **Cosmetic Aluminium Repair**
  This course is designed to upskill technicians to required standards on aluminium repair techniques and includes health & safety, tools and equipment required, repair techniques, a theory test and a practical skills assessment.
- **Electric and Series Hybrid Vehicle Awareness**
  The aim of this course is to give the delegate an understanding of the principles of electric and series hybrid vehicles and will discuss the construction, operation and identification of all of the main components and safety aspects when working with high voltages.
- **Mercedes-Benz Electrical and Fibre Optic Communication**
  This course is designed to give delegates an overview of the latest electrical & fibre optic communication used in Mercedes-Benz passenger cars.

E-Learning: if viewing online, click on the title for more information

- **Electronic Circuit Theory**
  E-learning designed to provide an understanding of electronic circuit theory including series/parallel connections, Ohm's Law, Power Law, Kirchhoff's First Law, DC/AC voltage, ground/positive -switched circuits, relays, duty cycles and amplitude, frequency and pulse width modulation.
- **Controller Area Networks (CAN) Multiplexing Systems**
  This course provides information about the function and operation of CAN-bus multiplexing systems, including items such as arbitration, electrical operation, error detection and rectification, protocol and topology.
- **Hybrid Vehicle Technology**
  Hybrid Vehicle Technology will form a substantial part of the total market for environmentally-friendly vehicles. Knowledge about this technology is essential for technicians in their daily working practice.
- **Alternative Fuels and Sustainability**
  Alternative Fuels & Sustainability forms an important part of today's emphasis on environmentally-friendly vehicles. This course provides essential knowledge about this technology.

Further **study**:

1. Telematics
2. Range measurement sensors – optical, LiDAR and RADAR.
3. Powertrian emissions.
4. Strength of materials – steel alloys, aluminium alloys

All CPD courses can be found online at www.theimi.org.uk/courses-and-events.

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