Implementation of New Test Sourcing Strategies within the Automotive Sector

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Introduction

Automobile design has progressed radically since the first mass production cars appeared about 110 years ago. It is in the last few decades though that things have really stepped up a gear, with the amount of electronic content increasing at an exponential rate. The engineering effort involved in developing and testing new car models has likewise escalated.

Until the early 1980s the electronics found in even luxury cars was fairly minimal. In contrast, today some vehicles will incorporate as many as 100 different electronic control units (ECUs). These ECUs can serve all manner of different purposes - from infotainment through to engine management, from lighting control to airbag deployment, from enhancing comfort to improving fuel economy.

Though ingenuity has brought us a long way already, there are two principal trends that are set to transform automotive design beyond all recognition. One we are already starting to see. This is the increasing prevalence of electric vehicles (EV) on our roads. Now we are on the verge of an even bigger upheaval though, with the prospect that in the relatively near future cars will not require any human involvement when it comes to driving, but will instead be fully autonomous.

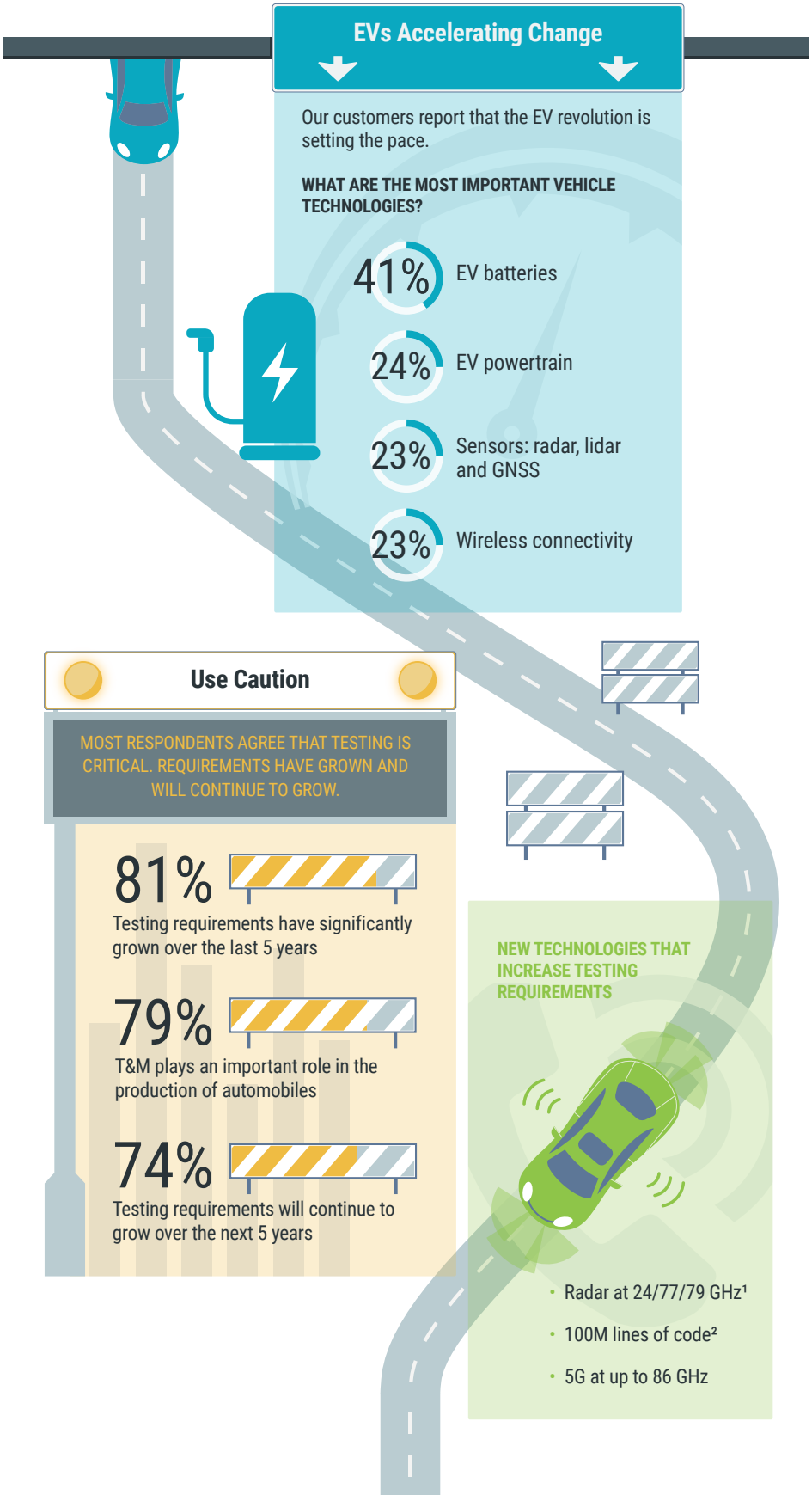
The incredible complexity of new vehicle designs and the amount of data they will need to deal with are going to present automotive manufacturers with many difficulties that they did not have to worry about before. To compound matters further, the development cycles that they need to contend with are shortening, budgets are getting tighter and the workforce available is increasingly overloaded.

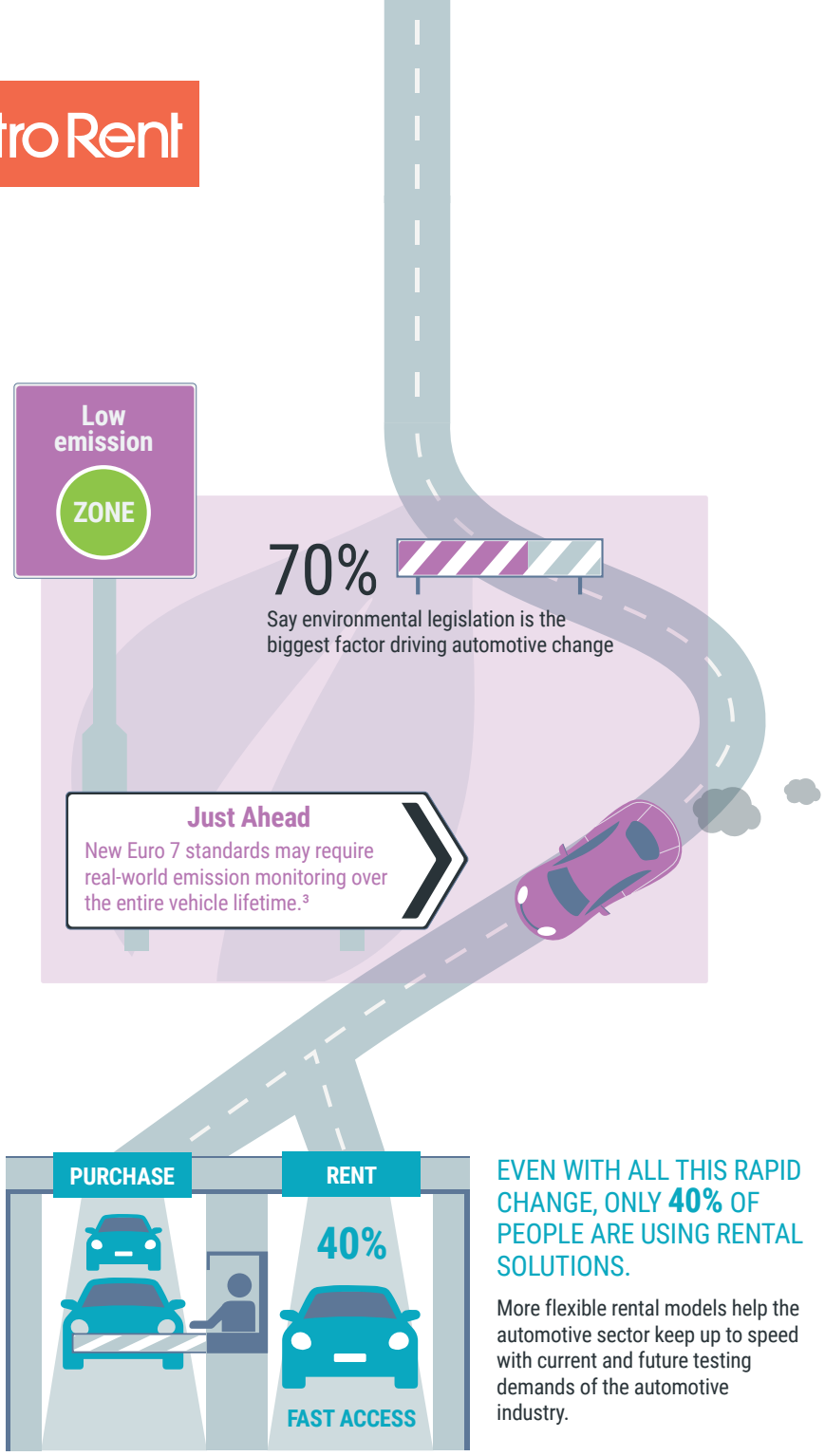
In a recent survey, Electro Rent reached out to members of the automotive industry community and asked them to share their opinions and knowledge on the future of automotive testing. Not only did it identify where technological innovation is at its most intense, but it also uncovered the key challenges that the industry currently faces and what needs to be done to address them.

The Electro Rent survey, which will be referred to throughout this white paper, shows that EV batteries/charging/powertrain, wireless/wireline connectivity and sensors are going to be the areas where future automotive engineering ventures will have particularly strong focus. There are some other interesting things to be discovered within the survey. 79% of those participating agreed that test and measurement is a vital aspect in the development and production of automobiles, with 74% expecting their testing requirements to increase over the course of the next 5 years.

Avoid Slowdowns in Automotive Testing

We asked our European automotive industry customers about their main concerns and considerations in automotive test over the next five years. Here's where their responses took us:





EVEN WITH ALL THIS RAPID CHANGE, ONLY **40%** OF PEOPLE ARE USING RENTAL SOLUTIONS.

More flexible rental models help the automotive sector keep up to speed with current and future testing demands of the automotive industry.

Switching to rental could improve your rate of innovation and reduce your time to market. Read on to learn about the latest automotive testing technologies and the technology sourcing solutions that could help accelerate your innovation.

Our experts will guide you to an optimal solution for automotive test.

[1] https://interferencetechnology.com/wp-content/uploads/2020/05/2020_Automotive_EMC_Guide.pdf
[2] https://www.visualcapitalist.com/millions-lines-of-code/
[3] https://www.autoexpress.co.uk/news/354437/euro-7-standards-eu-considers-lifetime-surveillance-every-new-car

The Changing Face of Automotive Test

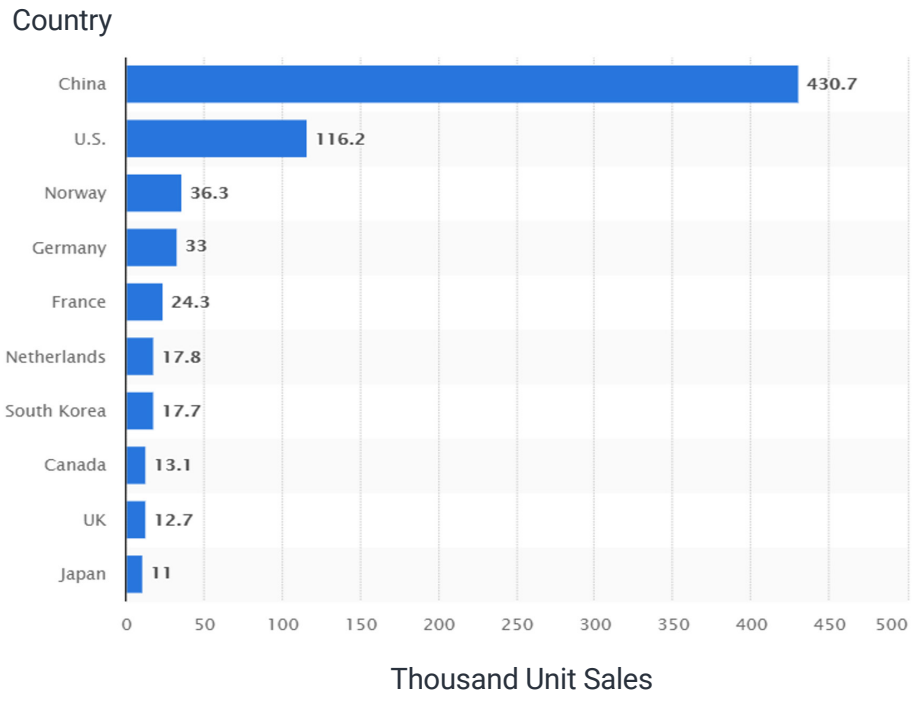
There are various different dynamics that are currently redefining key aspects of the automotive sector. In this next section the most prominent of these will all be described, followed by an outline of what the subsequent implications are for test engineers and what types of equipment they will need access to.

1.The emergence of EVs

With impetus coming from the need to curb carbon emissions and to conserve rapidly depleting fossil fuel resources, vehicle electrification will be at the foundation of future automotive engineering endeavor. Driven by international ecological legislation and government initiatives, a major shift is now underway from vehicle designs that are based on internal combustion engines to ones which are completely electrical, or at least hybrid.

Though until now EV sales have been fairly modest in comparison to conventional vehicles, momentum is definitely building. Figures compiled by both Canalys and EV Volumes show that there was approximately a 40% year-on-year increase in global EV sales in recent times, with annual sales reaching close to 3.2 million units in 2020 (compared to around 2.2 in 2019). Germany, China, Scandinavia and the USA are among the countries where EV uptake is currently at its highest.

Encouraged by ongoing investment in charging infrastructure from both the public and private sectors, it is predicted that the EV market will see strong growth in the coming years. Projections made by the International Energy Agency (IEA) envisage that there will be a 30-fold increase in the EVs on our roads between now and 2030, reaching 245 million vehicles by the end of that period.



As automobile manufacturers enter into the EV era, the key performance benchmarks that they want to achieve are very different from those that were priorities in internal combustion engine vehicles. Now it is much more about supporting longer ranges, rather than what speeds can be reached.

The main elements that make up an EV powertrain are as follows:

a) The battery, in which electrical charge is stored.
b) The on-board charger (OBC), which takes AC current from the mains supply and then provides charge to the battery in DC form.
c) The DC/DC converter, which lowers the high voltages coming from the battery to make them suitable for use by the EV's subsystems.
d) The inverter, which drives the electric motor that is responsible for the vehicle's traction.
e) The various power buses that connect all of these items to one another.
f) The battery management system (BMS), which monitors the battery's operation and protects against potential issues (such as thermal runaway, etc.).

All of these need to have detailed power analysis undertaken on them. Via this analysis it is possible for EV manufacturers to avoid potential power losses, maintain elevated operational efficiency levels, comply with relevant electro-magnetic compatibility (EMC) standards and assure ongoing safety. Advanced test equipment can be sourced to look at the charge/discharge behavior of battery cells, characterize the constituent power components, measure power conversion efficiencies and identify possible sources of voltage transients. The more widespread use of silicon carbide (SiC) and gallium nitride (GaN) based power discretes, plus increasing cell densities and new chemistries in EV batteries have significantly raised the performance thresholds that such test equipment needs to be able to deal with.

"With the accelerated growth of EVs, engineers must address new testing challenges. Voltage levels are transitioning from traditional 300/400VDC to 800/1000VDC. These voltages permit faster EV charging and increase power transfer, while reducing vehicle weight. Such factors are driving development of higher performing EV batteries, electric drivetrains, power converters, inverters and faster chargers. Today's EV test equipment needs to provide modular, scalable power, fast transients and integrated safety to effectively simulate real-world conditions. Rental allows access to world-class test equipment, and provides an opportunity to try before purchase with quick turnaround times.'

Martin Weiss
Product Director, NH Research.

The 9300 Series from NH Research is an all-in-one test solution that is optimized for use on the latest EV components and systems. This multi-functional unit serves as a battery cycler, bi-directional DC source and load, plus a battery emulator. Its wide operating envelope covers both lower (up to 600V) and higher (up to 1200V) power applications and is scalable up to 2.4MW in 100kW increments. Key applications include testing the battery module and pack, electric powertrain, EV supply equipment, DC converter, fast charger, etc.

2. The advent of x-by-wire

Over the last decade automotive design has been subject to a migration from the mechanical apparatus (which has been present in some form within cars since the very beginning) to more modern electrically-based systems. Originally featured in avionics systems, x-by-wire technology is now being employed in an increasing number of car models. There are two main motivations behind it. The first of these is to increase operational reliability, as the risk of mechanical failure (and the potential dangers this can have to vehicle occupants or other road users) is removed. Secondly, eliminating heavy mechanical hardware from the vehicle design means that a substantial reduction in weight can be realized - which translates into reduced fuel consumption, or extended range between battery recharges in the case of EVs.

There are supplementary benefits to consider too. These include more precise control and longer operational lifespan (since systems are not exposed to ongoing wear-and-tear of moving parts), as well as the ability for a vehicle's onboard computer to intervene if it perceives that a dangerous situation is arising and the driver is not fully prepared to react (this can result in the brakes being automatically applied, for example). Initially x-by-wire was incorporated into the throttle and gear shift functions of cars, but now functions that are safety-critical (such as steering and braking) are also utilizing it.

3. Internal communication

The heightened complexity of vehicles, with all the different ECUs incorporated into them, plus a multitude of sensors, actuators, motors and other devices all needing to transmit and receive data to/from them, means that the supporting communication infrastructure must be given a dramatic upgrade. The CAN and LIN buses that have provided in-vehicle connectivity for several decades are starting to prove outdated and inadequate. Networking that relies on Ethernet technology is becoming increasingly commonplace in automobile design. The 100M and 1G data rates that current Automotive Ethernet implementations can deliver will soon be supplanted by 10G network infrastructure - so that the demands of next generation on-board imaging systems and more sophisticated diagnostics can be met. Due to the safety-critical nature of many of a vehicle's core functions, low latency operation is mandated. For this reason, time-sensitive networking (TSN) protocols have now been made part of the multi-Gbit Automotive Ethernet standards.

The Automotive Ethernet infrastructure used in in-vehicle networking will call for the carrying out of comprehensive testing. To ensure standards compliance of the PHYs in a vehicle's ECUs, test engineers will need to ascertain that the signal integrity for each PHY is at an acceptable level. In order to do this, they will need to check various key parameters, among which will be:

a) Jitter levels
b) Signal distortion
c) Frequency deviation
d) Output losses
e) The bit error rate (BER) figure
f) Crosstalk rejection

When dealing with the unshielded twisted pair (UTP) cables of Automotive Ethernet infrastructure, the **Open Alliance TC9** specification enables 1000BASE-T1 conformance to be attained. By using the R&S®ZNB4 multi-port ZNB4 vector network analyzer (VNA) from Rohde & Schwarz, a highly effective TC9 compliance testing set-up capable of elevated levels of accuracy is straightforward for automotive engineers to implement.

With a bandwidth of up to 33GHz and a 100GSamples/s sampling rate, the **DPO70000DX oscilloscope from Tektronix** is very well suited to examining high-speed phenomena. It has 16 logic channels and an 80ps timing resolution. Working in conjunction with the TekExpress Automotive Ethernet software package, it provides a highly optimized solution from scrutinizing multi-Gbit in-vehicle networking infrastructure (with provision for 802.1Q TSN validation encompassed).

4. V2V/V2I

As well as having more effective high-speed internal communication, how the vehicle communicates with the outside world is also evolving. The advent of the 'connected car' means that information can be acquired from other vehicles, roadside infrastructure, traffic management systems and such like. This can be used to warn of possible traffic congestion, an accident, or adverse weather conditions on the road ahead. Vehicle-to-infrastructure (V2I) and vehicle-to-vehicle (V2V) communication can be achieved via a variety of different wireless protocols. The 802.11p WLAN protocol makes use of the 5.9GHz frequency band, providing a simple and cost-effective means for short range transmission at low data rates. As 5G technology matures, then cellular-based V2V/V2I is certain to gain increasing traction. This will offer a reliable, low latency medium capable of supporting data rates and transmission ranges that simply are not possible via 802.11p, and can deal better with obstructions too. It will also facilitate the storing of data back in the cloud for later analysis. Nevertheless, it is likely that the respective merits of these two options will mean there is a place for each of them in the years ahead, respectively serving different functional scenarios. The ability to test both of these technologies will therefore be mandated.

V2V/V2I test procedures will need to look at a wide array of different performance parameters. As well as assuring basic protocol conformance within laboratory or production line environments, these will also include meticulous field-based testing of network coverage, end-to-end delay, interference issues, etc.

Supporting a frequency range spanning from 10Hz through to 44GHz, the **R&S®FSV3000 spectrum analyzer from Rohde & Schwarz** is a valuable tool in the verification of V2X communication hardware, including in relation to the 802.11p protocol. It has an analysis bandwidth reaching 200MHz and a -90dBm (typical) sensitivity.

5. Augmented sensing functionality

The incorporation of advanced sensor technology, and the safety improvements that can thus be derived, are going to be a prominent aspect of next generation vehicle design. Forecasts recently made by Fortune Business Insights show that the already lucrative automotive sensors market will keep growing steadily over the next few years, reaching an annual worth of more than $8.5 billion by 2027.

Keysight's E8740A series automotive radar testers allow the generation and analysis of 24GHz, 77GHz and 79GHz frequency bands, with 2.5GHz to >5GHz analysis bandwidths being selectable. ±1dB amplitude accuracy levels and 10-bit resolution can be supported.

Though in the past there would be a relatively small number of sensors within the average car model, there can now easily be well over a hundred. Complementing those employed to take care of functions like tire pressure monitoring, engine temperature measurement, determining the position of mechanical apparatus and suchlike, there is now increasing use of sensors in a driver assistance context too. Imaging data captured by cameras is helping with parking and lane changing, and more sophisticated radar and LiDAR systems are now starting to be integrated into vehicles as well. Using RF and optical technology respectively, these systems are able to provide detailed 3D imaging data which can forewarn of potentially life-threatening situations so that appropriate actions can be taken.

"As the trend towards autonomous vehicles continues to gain momentum, new technologies, system integrations and security risks mean companies must incorporate more test functions to mitigate numerous issues, so they can improve their approach to system testing and increase safety."

Thomas Goetzl
Vice President Automotive & Energy Solutions, Keysight.

Intended for deployment in automobile production facilities, the R&S® AREG800 can be utilized in R&D and production to electronically simulate lateral moving targets in combination with QAT100. Like the Keysight E8740A series, this high-resolution radar test system (RTS) covers a broad array of frequency bands. It supports a 4GHz instantaneous bandwidth and can deal with object distances from 4m to 500m.

"Being able to simultaneously generate a large number of dynamic artificial objects makes it possible for the first time to run realistic and reproducible tests in lab environments. It can be used from pre-development through hardware-in-the-loop lab tests to validation of ADAS/AD functions integrated in the vehicle. It allows early error detection and so reduces cost significantly."

Jürgen Meyer
Vice President for Automotive Market Segment at Rohde & Schwarz

6. Conformance with EMC regulations
With automotive designs becoming more intricate and the quantities of electronics hardware being integrated into vehicles higher now than ever before, comprehensive EMC testing is a must. This will look at the emissions emanating from different parts of the vehicle and also effect these can have on sensitive components (as well as on the well-being of vehicle occupants).

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Formulating an Effective Test Equipment Sourcing Strategy

When looking to source equipment to attend to the various different test tasks already outlined, there are important points that automotive engineering teams need to ensure they are fully aware of. If these points are not given due consideration, then the efficiency of test operations - in terms of both capital expenditure and ongoing running costs - will be brought into question.

Firstly, test teams need to be in a position that they can fully utilize the available test assets which they have within their inventory. Often this is not achieved, as the location of equipment and its servicing/calibration status is not known. Such oversights can often mean that expensive items of equipment have to be purchased at the last minute to deal with sudden demands, simply because of a lack of organization. Costs are thereby accrued unnecessarily and budget wasted.

Next, it is crucial that test teams are able to keep up to date with the latest technologies. With new protocols emerging all the time, the period over which equipment remains useful can be seriously curtailed. This means there is a more acute risk of equipment that has cost a large amount of money to acquire becoming obsolete before there has been the expected return on investment. Also it is not always possible for engineers and engineering management to be sure which technologies they may need to be testing in the longer term. This is why flexibility to change the equipment used in their test rigs is of such benefit.

There are also uncertainties about demand. If equipment is no longer of use or is only required infrequently, then it still has certain costs associated with it. Keeping such equipment ties up capital that could be used for other purposes. On top of that, there are ongoing operational expenses that must be taken into account (in relation to upkeep, calibration, insurance, financing repayments, etc.). Conversely, there needs to be adequate provision for test activities to be ramped up quickly. For instance, once a prototype car model or EV battery goes into high volume production, more units of a relevant item of instrumentation will have to be installed at the manufacturing site. Access to equipment without being exposed to lengthy lead times is therefore paramount.

According to the data compiled in the recent Electro Rent survey, 77% of participants voiced their concerns that the pace at which test requirements are now changing is affecting their ability to keep their instrumentation inventory up to date. Then 65% identified the budget constraints they are subject to as a barrier to ensuring that adequate testing is done during automobile development projects. Despite all this, over 60% of participants rely almost totally on the purchasing of test equipment, with a mere 17% using a rental approach.

Given the worries that those involved in the survey expressed in relation to keeping their test inventory up to date and the budget pressures they are under, it seems surprising that the majority are still following a route where they have to purchase new equipment. It suggests that such practices are too deeply ingrained into the business culture, even though they are no longer that well aligned with what the industry actually needs.

There clearly has to be a change in the organizational behaviors that the automotive sector depends upon when it comes to testing - so that it is better able to address the challenges that are now being faced. The heavily purchasing-centric strategies that are still commonplace need to be reconsidered and their economic viability thoroughly scrutinized.
Simply comparing the cost of renting equipment to the price tag that comes with purchasing equipment does not give an accurate assessment of the situation. More detailed calculations, which take into account all of the operational expenses already mentioned, show that renting is more financially prudent than many people realize. Though a less capital investment-driven strategy is definitely going to be beneficial for even the largest automotive companies, it seems almost completely unavoidable to the new smaller-sized entrants into certain areas of the market (such as EVs) who lack the available funds to make big purchases.

Engaging with a Test Sourcing Specialist

The in-depth sourcing advice provided by Electro Rent has proved itself to be invaluable to automobile manufacturers and technology suppliers. Via consultation with the application specialists at Electro Rent, it is possible to specify which items of equipment are needed to meet particular test requirements. Then consultation with the company's logistical experts means that the best sourcing method can also be decided upon - choosing from short- or long-term rental, operational leasing, the purchase of used equipment or rent-to-buy options.

Alongside all this the asset management services that Electro Rent can offer present further operational advantages to customers. These allow access to detailed and constantly updated information relating to each item of equipment that a customer currently has within its inventory. This information will encompass the equipment's manufacturer and its model type, plus key performance figures. In addition, there will be details on where it is situated, upcoming projects it is assigned to and its servicing/calibration status. Through its superior asset optimization capabilities, Electro Rent is able to help customers to maximize utilization of their test equipment and avoid the unnecessary purchases (as mentioned earlier) to attend to unforeseen demands. Capital is no longer tied up in redundant equipment - as such items can be identified, then sold off to make funds available again.

An essential tool that Electro Rent offers is the MyER Portal. This centralizes everything relating to test assets in one place - thereby delivering unprecedented visibility to customers, so that operations will continue to run as efficiently as possible. Details on the whereabouts of equipment, its current condition, calibration/servicing records, contracts, reports and suchlike, may all be rapidly accessed via this intuitive online platform. Using it, test engineers and procurement staff are able to accurately align equipment inventory with current/future demands. This means that better informed decisions can be made in a timely manner, and test asset utilization can thus be maximized.

Conclusion

Companies involved in the automotive sector need to be able to react to changing technology requirements more rapidly - as different standards emerge and development cycles must be completed at a more accelerated pace. At the same time, the uncertainty about which technologies and standards will see wholesale adoption means that there are significant risks to factor in too.

The dynamics revealed by Electro Rent's recent survey all point to the need for the automobile industry to utilize more effective equipment sourcing options. Those participating in it expressed strong concerns about the changing test landscape and its implications - doubting the ability of current sourcing strategies to meet the demands of fast moving technological advances. However, despite all this, the majority of those participating in the survey admitted to still relying mainly on the purchasing of brand new equipment - rather than looking at what alternatives to this approach are available. This suggests that a change in mindset is still required.

In the years ahead, in order to mitigate the evident risks and increase efficiency levels, automotive test operations will need to migrate away from a solely purchasing-oriented philosophy. As this white paper explains, they should instead look to adopt a strategy which provides their engineers with an array of different potential sourcing options, so that the best fit can be decided upon.

Electro Rent

Smarter Solutions for Testing & Technology

About Us

Electro Rent is a leading global provider of test and technology solutions that enable customers to accelerate innovation and optimize asset investments. Our rental, leasing, sales, and asset optimization solutions serve innovators in communications, aerospace and defense, automotive, energy, education, and electronics industries, and we have been doing so since 1965.

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