IJIREEICE ISSN (O) 2321-2004, ISSN (P) 2321-5526

International Journal of Innovative Research in Electrical, Electronics, Instrumentation and Control Engineering

Impact Factor 8.021 ⁜ Peer-reviewed & Refereed journal ⁜ Vol. 12, Issue 4, April 2024

DOI: 10.17148/IJIREEICE.2024.12440

Advancement in Electric Drives

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Abstract: In today's dynamic auto industry, original equipment manufacturers (OEMs) are driving innovation and progress. Traditionally, they have designed, developed, and produced various components of internal combustion engine (ICE) vehicles. As the world shifts towards software-defined vehicles, however, their role is evolving to include building and deploying elements within the automotive operating system (OS) for a seamless user experience.

Keywords: OEM, drives, motors, electric vehicles.

I. INTRODUCTION

Automotive OS forms the backbone of a car, managing and controlling functions including braking, infotainment, and safety. This means that OEMs must master increasingly complex car elements, such as sensors. Meanwhile, incompatibilities and poor harmonization among software car elements pose significant issues. If left unaddressed, these issues can hinder innovation and impede electric vehicle (EV) adoption, leading to environmental and economic setbacks.

II. WHAT IS AN OEM – ORIGINAL EQUIPMENT MANUFACTURER?

In the computing world, for example, an Original Equipment Manufacturer is sometimes understood to be a company that assembles products (or systems) out of component parts (or subsystems) manufactured by others. Where this practice consists mainly of bundling and branding, it is in other contexts more helpfully known as Value-Added Reselling; and the OEM more normally identified as the manufacturer of the component parts. Where, though, one company is supplied with component parts by another but still manufactures its own generic, unbranded product – typically to be sold on down the supply chain to a further company more associated with end products – then it more closely approximates to an OEM as most understand it. An Original Equipment Manufacturer is, in short, most commonly defined as any company that manufactures machinery to sell to other companies – either as component parts or for them actually to use within their own manufacturing processes. Drives and drive systems are of fundamental importance to OEMs in a number of fields – in all fields, in fact, where machine operation demands safe and close controllability, dynamic responsiveness and smart energy consumption.

A. OEM and applications for variable frequency drives

Any OEM that specialises in supplying heat transfer equipment, for example, relies on drive technology in an array of products – whether it be the fan and pump motors of an HVAC system or the compressors and other mechanisms used to regulate the temperature in commercial refrigeration solutions.

Elevators, cranes, indeed all types of conveyor machinery, are another class of industrial equipment that makes significant use of drive control. And an OEM‟s clients in this field – construction sites, mining operations, ports and factories, as well as end product retailers – these days typically appreciate smooth and precise motion control as an industry norm. Original Equipment Manufacturer is, in fact, a thoroughly diverse sector – and the range of relevant drive applications therefore hardly less so. The technology may be found in anything from the slicing apparatus used to deliver identically-sized portions of beet in sugar factories; to the kind of welder that needs to vary speed according to the section of machine it is putting together; to the lapping and polishing machine accurate enough to work with parts of a timepiece almost too small to see with the human eye. And, of course, if intelligent drives have revolutionised performance standards in traditional industries such as these, they are equally crucial players in more experimental territory – and for a new generation of OEMs. The world of commercial robotics, for example, uses electric drives and motors as staple components of its computer-controlled machines. And the growth rate of few industries is expected to match that of electric cars. Successful Original Equipment Manufacturers typically have strong collaborative relationships with other manufacturers and suppliers.

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Motion control technology companies value OEMs as a significant client base of their own and typically work side by side with them on bespoke design projects, as well as providing them with long-term technical support. Where the associations are particularly close or committed they can graduate into full-blown business partnerships.

III. THE ADVANTAGES OF EASY TO USE INDUSTRIAL DRIVES IN MANUFACTURING

The closeness of these relationships exists despite the fact that in a number of ways the drives supplied to OEMs have – in line with other aspects of automation – become increasingly easy to install and operate without in-depth specialist training. Uncomplicated motor pairing and intuitive interfaces with simple menu layouts are signs of how accessible drive solutions have become.

The ease with which much industrial equipment can now be sourced, particularly thanks to the development of online supply channels, has to some extent destabilised conventional supply-and-demand structures; it has certainly made those structures less hierarchical. And it is possible that in the long run this loosening may significantly alter the ways in which OEMs operate; already, for example, some are beginning to compete with aftermarket specialists for direct supply relationships with end-users. Other factors, however, are seeing Original Equipment Manufacturers redouble their commitments to established alliances. Market currents have sped up considerably under pressure of consumer demand. And the accelerating pace of technological change means that purely in-house expertise will increasingly feel its limitations. For these reasons alone it is currently in the interest of all players in the supply chain to coordinate their operations as closely as possible. The ongoing role industrial drives have to play in the making of OEM products is therefore likely to bring with it a good deal of forward-thinking conversation: whereby drive engineers can learn about the kind of equipment requirements that originate within the consumer end of the market, and manufacturers gain insight into opportunities presented by the latest technology. Original Equipment Manufacturers are in this scenario well-placed to capture and disseminate technological advancements to areas of industry – such as agriculture or construction – where modernisation may be much desired but is, for various reasons, slow in coming. This is particularly true when it comes to issues of electrification and making systems autonomous. And given that electrification and automation are trending across the industry more strongly than ever before, it seems inevitable that the importance of drive systems to Original Equipment Manufacturers will continue to grow.

IV. THE FUTURE OF ELECTRIC DRIVE MODULES

The growth of the electric drive modules is closely linked to the demand for electric vehicles, and the road toward an EV future is not without potholes. While the industry has highly ambitious plans for EVs, the world is not prepared with enough charging infrastructure. The exorbitant prices of lithium are an added issue due to shortage and rising demand. The upward price trajectory continues unabated in 2022, hitting the automakers‟ bottom line hard. Recent investment plans of Chinese EV giant BYD to buy lithium mines in Africa reinforce the trouble the industry is facing.

The sudden spike in electricity prices in Europe due to the tumultuous political environment has made the future of EVs vulnerable. Although the momentum created due to environmental concerns and favorable policies will likely keep the demand for EVs soaring in the coming decade, OEMs will have to revisit their strategies to keep themselves going. The industry will compensate for the rising input costs with innovations like eDMs.

V. NEW DESIGNS, TOPOLOGIES

A. AXIAL FLUX MOTORS

One of the key emerging motor types is the Axial flux motor which is gaining momentum in the electric vehicle sector. Axial flux motors have many EV design advantages over their radial flux counterparts. Magnetic flux is parallel to the axis of rotation in an axial flux motor (compared to perpendicular in radial flux machines). Axial flux motors provide substantially more power while having a lower weight density.

Although used for many years in stationary applications such as elevators and agricultural machinery, over the past decade many developers have improved the technology to make electric motorcycles, airport containers, delivery trucks, electric vehicles, and even aircraft.

Industry players viz. Mercedes has shown keen adoption with the investment and acquisition of YASA. It implies a greater interest in axial motors for automotive applications. Daimler will be using YASA for their motors in the upcoming AMG electric platform and Renault has partnered with WHYLOT to use axial flux motors in their hybrids starting in 2025.

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Axial flux motors often have power densities above 6Kw/kg and still have good efficiencies.

With emerging e-mobility trends, the adoption and demand of Axial flux motors are expected to witness huge growth in coming years especially in high-performance vehicles and in applications where power density is critical.

1. Key application domain: Ideal for high torque density and space-constrained applications
2. Key challenge: Production and Thermal issues

Interesting development to look at Additive manufacturing player ExOne is working with Maxxwell Motors to develop a copper e-winding design for its axial flux electric motors that can be printed with metal binder jetting technology.

B. IN-WHEEL MOTORS

One of the emerging electric motor configurations is the "INWHEEL MOTOR or Hub motor" with a direct drive mechanism. It can either be radial flux or axial flux motors. While a few companies have developed concepts that are marketed as IWMs, most include motors that are mounted far from the wheel (The Eco-move Q wheel, Nissan blade glider concept, etc.). Protean Electric, Elaphe, etc. are major propones of IWMs.

Fig. 1 Ecosystem – Proteam Electric: In-wheel/Hub Motors

The modular approach of this system enables it to be retrofitted to any existing vehicle platform with no vehicle modifications (Some systems like the brakes have to be removed, but nothing needs to be modified).

Slovenia-based startup GEM motors have developed a patented modular multiphase technology to perfect its GEM motor. Its solution is at the forefront of the technology trend toward a fully integrated electric motor near the wheel. This technology simplifies the electrification of the vehicle and minimizes the number of parts while reducing weight and space.

Industry developments in „In-wheel-motor" adoptions

- Aptera Motors has announced the highly efficient Aptera, an enclosed solar-powered three- wheeler using the Elaphe hub motor.
- Lightyear has announced a solar-powered car with a hub motor, the Lightyear One.
- Lordstown Motors has announced a 4WD pickup truck, the Lordstown Endurance, with a motor from Elaphe.
- Israeli startup REE has announced a Corner module that combines engine, brake, suspension, software, and steering with cables, and plans to use these four modules in vehicle delivery and pickup trucks.
- Toyota"s subsidiary, Hino Motors, showcased a 6×6 truck chassis concept called "FlatFormer" using similar technology at the 2019 Tokyo Motor Show.
- SWITCHED RELUCTANCE MOTORS (SRMS)

Switched reluctance motors (SRMs) are coming up as an emerging alternative for e-mobility applications, with decades

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of reliability testing in zero-fault-tolerant applications, and no rare earth. Recent advances in power electronics and IoT are boosting SRMs to new, highly energy-efficient applications.

Some of the key developments in SRM technology include:

1. Enedym Inc. Secures $15 Million Investment to Accelerate Business Plan
2. Turntide Technologies raised $225 million and acquired three companies to speed up its route to market.
3. Advanced Electric Machines (AEM), a spin-out from Newcastle University, developed the HDSRM (High- Density Switched Reluctance Machine), targeting the commercial vehicle segment.

C. SYNRM-IPM (PMASYNRM)

SynRM-IPM (PMaSynRM) has become another attractive electric motor type in the automotive industry for small electric vehicle segments. It outperforms other variants of traction motors in delivering higher torque with an increase in saliency due to air barriers and enhanced speed capability.

SynRM-IPM is a combination of an internal permanent magnet motor type and a synchronous reluctance motor rotor type that achieves more desirable characteristics in low-speed and high-speed high-efficiency EV applications. The advantages of adding PMs to the synchronous reluctance motor rotor construction are the increased motor power factor and thus reduced motor stator ohmic losses. The construction of SynRM-IPM involves placing small permanent magnets (often simpler ferrite ones) in some of these voids of SynRM to take advantage of both magnetic and reluctance torque while minimizing cost and the back EMF (or counter-electromotive force) high-speed inefficiencies that permanent-magnet motors suffer.

Tesla Model 3 features a SynRM-IPM motor. Tesla is not the first to use this type of motor, but its version is considered one of the best. Tesla‟s specific innovation is the segmented magnets (four parts instead of the more typical single solid magnet). It helps to reduce the eddy currents and lowers the risk of magnets overheating. OEMs have been utilizing SynRM-IPM for hybrid and EVs.

The SynRM IPM technology is adopted for e-mobility applications by Tesla and Toyota and more. The use of high-efficiency and high-density motors is also spreading in traction, including the road ambit

VI. CONCLUSION

An Original Equipment Manufacturer or OEM is a company that manufactures and sells products or parts of a product that their buyer, another company, sells to its own customers while putting the products under its own branding. OEMs commonly operate in the auto and computer industries. To make electric vehicles lighter, perform better, and a viable alternative for customers, OEMs have been working on the upgradation of the structure, performance, weight, and more. One of the most exciting advancements in this way is the development of an EV Drive Module (eDM).

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