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Review

Time Factory

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Abstract: Have you asked yourself how you will look over 15 years? At the Bosch factory in Jucu, we saw a time machine that can help you to travel for 15 years in the future. And the technologies used seem to have come from the reality of the next decades. This "time machine" is, in fact, part of Bosch's Engineering, Quality and Validation Laboratory (EQV). It's the test room, where the products are "aged" for 15 years to analyze how they can withstand the passage of time and the action of natural phenomena - storm, equatorial rain or frost. The EQV lab concept was created from the idea of synergy between R&D departments and production, a configuration that can provide a holistic view of Bosch products that are being analyzed from the initial development phase of the product until the product returns to the laboratory to investigate possible defects that occurred during their use. "We test the product's resistance to equatorial rain, for example. If it is an electronic component mounted on a machine that will go to South America and we know that there is very high humidity in that area, here we simulate the aging of samples in a more accelerated way, "explains Grasim Robert, head of the analysis group of the EQV lab. But they are not the only tests the products are subjected to. The water resistance of the samples is also done with a very strong 6 bar jet and the water has a force similar to that coming from a fire hose. Other tests check for resistance to different types of dust - for example, Arizona powder is more abrasive and worn plastic components, while ash-containing dust can lead to short-circuits - or saline mist, which activates corrosion mechanisms. In the climatic rooms, explains Grasim Robert, there are several parameters: Time, temperature and humidity. Depending on ISO standards and customer requirements, the test team varies these three physical parameters. There are tests that last for 10-12 months. In other words, a 15-year journey in the future still takes a few months, but taking into account the pace with which technology evolves, it is obvious that this duration is reduced.

Keywords: Robots, Mechatronic Systems, Structure, Machines, Kinematics, Dynamics, Synthesis, Automation, Quality and Validation Laboratory, Bosch, Possible Defects, Water Resistance

Introduction

In the past, it has been a matter of setting up quality sections in each enterprise to check the quality of the parts manufactured before they are mounted on the machines to predict the problems of inappropriate parts or even scrapes that could have slipped on a car and spoil its new functionality or create a function beyond the indicated and desired parameters. That's why it has always been a great price for the "quality and control" service. Later, non-destructive control devices have emerged and have been imposed in front of traditional control methods. However, all these methods can not predict how that piece will behave, as a component of a machine, in its operation, dynamic, over time and when it will begin to wear out and deteriorate. For this reason, it has become a question of wider control of important parts with dynamic operation with many repeated requests, control showing the ability of the piece to withstand in time. Because this control should have lasted for years or decades, a time reduction method was used to force the task quickly with special vehicles, as if time would flow faster over it, the wear of the piece, is much faster while component track is checked, measured and used prematurely, intensively on a specialized machine.

A Bosch plant of this kind is that from Jucu (a locality in Romania).

If one takes for example the cars that are today the world's number one in production and importance, it is enough to think that a more modern modern car has around 15,000 pieces, which complicates things a lot when all these parts must be controlled and checked in terms of their quality and especially of the endurance, i.e., their resistance over time (especially for the component parts of the moving mechanisms and assemblies).

In engine mechanism is a mechanism of a force machine which, in the case of an engine machine, transmits and eventually transforms the movement caused by the internal energy transformation of the working agent (combustion gases, steam, compressed air) into the motor shaft, or in the case of generating machines (e.g., piston compressors), vice versa, from the shaft to the working agent.

In motor machines, the mechanical work is initially obtained in the form of reciprocal movement of the piston in the cylinder. The motor mechanism turns this movement into a continuous rotary motion of the shaft.

For standard internal combustion engines, the engine is based on a crank-shaft mechanism. By extension of language, the motor mechanism means not only moving parts but also fixed ones to the frame (chassis, etc.), even if they move with the vehicle it propels (motor vehicle, locomotive, airplane, boat, etc.).

Components considered to be fixed are:

- The engine block
- Cylinder
- Engine cylinder
- Intake manifold
- Exhaust manifold
- Bearing cams, along with the Cartridge of the bearings

Mobile components are:

- Piston
- Segments
- Pin
- White, along with the cufflinks
- Crankshaft
- The flywheel, along with the torsion oscillator

The distribution mechanism is an auxiliary system of the internal combustion engine, the steam engine having the function of correlating the filling of the engine cylinders with fuel, steam, air and flue gas or air.

The distribution mechanism is used in almost all four-stroke internal combustion engines, except for the Wankel engine and two-stroke engines.

Depending on the type of engine to which it is applied, the distribution may be for four-stroke or two-stroke engines.

The distribution to two-stroke engines, in general, is without valves and has window-in-cylinder cylinders that are closed or open by moving the piston, which is also called light distribution. Two-stroke engines, especially those with compression ignition, have only intake or exhaust valves.

The four-stroke engine distribution uses a valve mechanism that can be operated mechanically, pneumatically, magnetically or hydraulically. In most cases (mechanical, hydraulic), the valves are driven by spikes or directly by the camshaft.

Following the position of the valves, the distribution mechanism may be with side valves, with valves in the head, or with a mixed distribution mechanism.

Side valve distributor mechanism (SV; eng., Side Valves) for example small engines with a narrower (low) cylinder head. In this case, the valves are in the engine block or the cylinder.

Distribution mechanism with valves in the head, with this mechanism the valves, are mounted in the cylinder above the piston.

Mixed distribution mechanism when the valves are also mounted in the engine block and cylinder head.

After camshaft mounting, there is a camshaft mounted camshaft mechanism and camshaft mounted on the cylinder head.

On the crankshaft mounted camshaft, the valves are hinged by hinges, their rods and tilts (OHV, eng., Over Head Valves).

On camshaft mounted overhead camshaft (OHC), the valves are driven by swinging or direct valve engagement.

After engaging the camshaft:

- Belt
- Chain
- Gear

The distribution system of an internal combustion engine for automobiles is the set of all parts that allow for the regular change of gas from the cylinders. To function, an internal combustion engine needs fresh air or an air-fuel mixture to be introduced into the cylinders instead of residual flue gases to be discharged. Briefly, the distribution system provides fresh air/mixture into the cylinders and flue gas outlet.

Four-stroke engines have valve distribution systems. There are also distribution systems with lights/slides (two-stroke engines) or drawers (racing cars) or combined, lights and valves (two-stroke engines), with components:

- Camshaft drive gear (belt drive)
- Cylinder
- Drain connection channels
- Exhaust valve
- Exhaust valve hatch
- Spindle shaft (evacuation)
- Clavicle shaft (intake)
- Inlet valve
- Admire valve hatcher

The toothed drive wheel is connected via a crankshaft timing belt. The crankshaft position must be synchronized with the camshaft position because opening and closing of the valves are made according to the position of the pistons in the cylinder. For the system shown, the valves are actuated via the guides (Rulkov *et al*., 2016; Agarwala, 2016; Babayemi, 2016; Gusti and Semin, 2016; Mohamed *et al*., 2016; Wessels and Raad, 2016; Maraveas *et al*., 2015; Khalil, 2015; Rhode-Barbarigos *et al*., 2015; Takeuchi *et al*., 2015; Li *et al*., 2015; Vernardos and Gantes, 2015; Bourahla and Blakeborough, 2015; Stavridou *et al*., 2015; Ong *et al*., 2015; Dixit and Pal, 2015; Rajput *et al*., 2016; Rea and Ottaviano, 2016; Zurfi and Zhang, 2016a; 2016b; Zheng and Li, 2016; Buonomano *et al*., 2016a; 2016b; Faizal *et al*., 2016; Cataldo, 2006; Ascione *et al*., 2016; Elmeddahi *et al*., 2016; Calise *et al*., 2016; Morse *et al*., 2016; Abouobaida, 2016; Rohit and Dixit, 2016; Kazakov *et al*., 2016; Alwetaishi, 2016; Riccio *et al*., 2016a; 2016b; Iqbal, 2016; Hasan and El-Naas, 2016; Al-Hasan and Al-Ghamdi, 2016; Jiang *et al*., 2016; Sepúlveda, 2016; Martins *et al*., 2016; Pisello *et al*., 2016; Jarahi, 2016; Mondal *et al*., 2016; 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Perumaal and Jawahar, 2013; Petrescu, 2011; 2015a; 2015b; Petrescu and Petrescu, 1995a; 1995b; 1997a; 1997b; 1997c; 2000a; 2000b; 2002a; 2002b; 2003; 2005a; 2005b; 2005c; 2005d; 2005e; 2011a; 2011b; 2012a; 2012b; 2013a; 2013b; 2013c; 2013d; 2013e; 2016a; 2016b; 2016c; Petrescu *et al*., 2009; 2016; 2017a; 2017b; 2017c; 2017d; 2017e; 2017f; 2017g; 2017h; 2017i; 2017j; 2017k; 2017l; 2017m; 2017n; 2017o; 2017p; 2017q; 2017r; 2017s; 2017t; 2017u; 2017v; 2017w; 2017x; 2017y; 2017z; 2017aa; 2017ab; 2017ac; 2017ad; 2017ae; 2018a; 2018b; 2018c; 2018d; 2018e; 2018f; 2018g; 2018h; 2018i; 2018j; 2018k; 2018l; 2018m; 2018n).

Materials and Methods

Have you asked yourself how you will look over 15 years? At the Bosch factory in Jucu, we saw a time machine that can help you to travel for 15 years in the future (Fig. 1). And the technologies used seem to have come from the reality of the next decades.

Fig. 1: Bosch's Engineering, Quality and Validation laboratory (EQV) test room

This "time machine" is, in fact, part of Bosch's Engineering, Quality and Validation Laboratory (EQV). It's the test room, where the products are "aged" for 15 years to analyze how they can withstand the passage of time and the action of natural phenomena - storm, equatorial rain or frost. The EQV lab concept was created from the idea of synergy between R&D departments and production, a configuration that can provide a holistic view of Bosch products that are being analyzed from the initial development phase of the product until the product returns to the laboratory to investigate possible defects that occurred during their use. "We test the product's resistance to equatorial rain, for example. If it is an electronic component mounted on a machine that will go to South America and we know that there is very high humidity in that area, here we simulate the aging of samples in a more accelerated way, "explains Grasim Robert, head of the analysis group of the EQV lab.

But they are not the only tests the products are subjected to. The water resistance of the samples is also done with a very strong 6 bar jet and the water has a force similar to that coming from a fire hose. Other tests check for resistance to different types of dust - for example, Arizona powder is more abrasive and worn plastic components, while ash-containing dust can lead to short-circuits - or saline mist, which activates corrosion mechanisms. In the climatic rooms, explains Grasim Robert, there are several parameters: Time, temperature and humidity. Depending on ISO standards and customer requirements, the test team varies these three physical parameters. There are tests that last for 10-12 months. In other words, a 15-year journey in the future still takes a few months, but taking into account the pace with which technology evolves, it is obvious that this duration is reduced (Voinea, 2017).

A visit to the Bosch Factory is the perfect opportunity to see the latest technology at work in the Industry 4.0 context. The Bosch Production Unit uses the latest IT equipment and manufacturing infrastructure in the form of a Manufacturing Execution System (MES) that connects and controls all workstations to provide 100% traceability of products starting from the first production stage in the Surface Mounting Technology (SMT) area up to the final stage, the packaging area, which includes automatic recording in the ERP system (SAP).

For example, each electronic board has its own identification code and it can be mounted from 1,000 to 50,000 components. Also, each material has an identification code and factory machines "know" exactly what parts they put on each plate. "Factory-installed machines are state-of-the-art. Each electronic plate is populated with different components and these machines populate six products in parallel. The only intervention of man is when the machine is left without components, "explains the Bosch representative, who was the guide to the robots working at the Jucu factory. Every 20 sec a tag comes out of the production line, each with its own code containing traceability information that will be kept for 10 years. "So we know from what batch of materials a particular product has been made, at what date and where each component has passed," adds the Bosch representative.

This new working environment with a real-time, real-time database of production lines stimulates new projects, such as Single Pin Insertion (SPI) process monitoring, a pins insertion process. The new IT infrastructure built on Hadoop Big Data Analytic Value Stream Cloud technology is developed in collaboration with the Bosch Automotive Electronics data center's data center for data analysis services and enables, among other things, real-time visualization of all relevant process parameters.

For an even faster implementation of new functions, the automotive production unit in Cluj continues to develop products from other Bosch locations. For example, machines are equipped with NFC (Near Field Communication) labels. By scanning them with smartphones, service staff can immediately check the availability of spare parts, accessing all machine documentation and more. The provision of production materials to all workstations is controlled by labels that can be read by the computer. Logistics monitoring can be easily achieved by recognizing RFID (RFID) tags read remotely.

But we can not talk about Industry 4.0 without interconnecting with Work 4.0 and Bosch invested 6 million euros in the Training Center at the automotive electronics factory. The center is devoted to the preparation of students in the dual educational system, but also to the continuous development of the employees. The dual education system allows pupils to apply the theoretical knowledge acquired within the school, their work at the factory being based on the school curriculum of their school. "Our global experience demonstrates that such long-term investment creates an advantageous situation for the company and the employee," says Konrad Kaschek, general manager of the Bosch plant in Cluj. At the Jucu factory, over 60 students enrolled in the Bosch Dual School program for the 2017-2018 school year and at the group level, more than 120 high school students and vocational schools in Romania are part of these programs. The company collaborates with Aurel Vlaicu Technological High School in Cluj-Napoca for the electromechanical profile and with the Reformed Theological High School for Electronics and Automation.

Bosch produces electronic control units in the factory in Cluj for: driving assistance, energy management and safety and comfort management. In 2015 and 2016, the auto parts factory added new products to its own portfolio, including airbag components and parking assistance systems. At the same time, Cluj is the only place where Bosch produces electronic control units for eBike (Voinea, 2017).

Results and Discussion

Hydraulic fracture stimulations generally result in microseismicity that is associated with the activation or extension of pre-existing microfractures and discontinuities. Microseismic events acquired under 3D downhole sensor coverage provide accurate event locations outlining hydraulic fracture growth. Combined with source characteristics, these events provide a high-quality input for seismic moment tensor inversion and eventually constructing the representative Discrete Fracture Network (DFN). In the study, one investigates the strain and stress state, identified fracture orientation and DFN connectivity and performance for example stages in a multistage perf and plug completion in a North American shale play. We use topology, the familiar concept in many areas of structural geology, to further describe the relationships between the activated fractures and their effectiveness in enhancing permeability. One explores how local perturbations of stress state lead to the activation of different fractures sets and how that affects the DFN interaction and complexity. In particular, we observe that a more heterogeneous stress state shows a higher percentage of sub-horizontal fractures or bedding plane slips. Based on topology, the fractures are evenly distributed from the injection point, with decreasing numbers of connections by distance. The dimensionless measure of connection per branch and connection per line are used for quantifying the DFN connectivity. In order to connect the concept of connectivity back to productive volume and stimulation efficiency, the connectivity is compared with the character of deformation in the reservoir as deduced from the collective behavior of microseismicity using robustly determined source parameters.

Conclusion

The EQV lab concept was created from the idea of synergy between R&D departments and production, a configuration that can provide a holistic view of Bosch products that are being analyzed from the initial development phase of the product until the product returns to the laboratory to investigate possible defects that occurred during their use. "We test the product's resistance to equatorial rain, for example. If it is an electronic component mounted on a machine that will go to South America and we know that there is very high humidity in that area, here we simulate the aging of samples in a more accelerated way, "explains Grasim Robert, head of the analysis group of the EQV lab.

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Ethics

This article is original and contains unpublished material. Authors declare that are not ethical issues and no conflict of interest that may arise after the publication of this manuscript.

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