Creation of a New Method for the Application of Lubricant in Automotive Control Cables

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ABSTRACT: The competitiveness established in the automotive industry implies continuous improvement in all information and action areas. It is therefore very important to be mindful that all manufacturing and logistics activities produce waste. In this regard, and taking into account the manufacturing cycle of control cables for the automotive industry, it was found that a large amount of lubricant was lost during the task of injecting grease into the spiral used in the control cables used to drive motor vehicle doors, windows and brakes. The industrial activity was followed carefully leading to the identification of the key causes of the waste and a brainstorming was conducted enabling the exploration of new ideas about how to solve the problem. A novel equipment has been developed, and all the logistics around the supply task have also been cared for. The new approach developed, as well as the redefinition of the logistical method of supplying the lubricating grease to the production lines, made it possible to make the process more versatile for the admission of different grease packs, as well as to allow better use of the existing grease in the reservoirs, resulting in a reduction of more than 70 per cent of the grease waste.

KEYWORDS: Automotive Industry, Command Cables, Environment, Lubrication, Mechanical Design.

INTRODUCTION

In the global manufacturing landscape the automotive industry is an extremely significant element. According to statistics released by the OICA-International Association of Motor Vehicle Manufacturers, over 97 million vehicles were manufactured worldwide in 2017, marking a rise of 2.36 per cent over the previous year. Because of the competition of this operation market, both businesses are continuously seeking to be able to stand out for creativity, a range of models and appealing price from the customers. Atomization has acquired a specific prominence in the main assembly lines, both in the sheet metal stamping process and in the body welding phase of the vehicles. Truth in the manufacture of automotive components is no longer linear, with various levels of automation depending on the product, the manufacturer and the country it is installed in. Atomization generally occurs in larger components and countries where labour costs are higher, whereas manual manufacturing is commonly associated with countries with lower labour costs and low value added goods. In any case, the movement towards the automation of most processes is increasing, with a view to quality control and improved competitiveness [1], [2]. The transition from manual to automated processes has been strongly studied and is one of the main research pillars in the fields of mechanical engineering and industrial control engineering. The work presented here aims to contribute to an extension of the knowledge in the area of the project of equipment capable of increasing the productivity and to assure with greater rigor the quality of the product.

LITREATURE REVIEW

The automotive component industry has moved between many tasks that are not so easy-to-win: jointly rising efficiency and versatility, maintaining higher quality levels. To encourage the gradual change from intensive labour-intensive component manufacturing to a capital-intensive method, some intermediate approaches have been made in the manufacture and assembly of some components, the manufacture of which cannot be fully automated. The process automation solution can be applied as a whole or in a piecemeal fashion. Then there is a bibliographical analysis of how certain researchers have supported the automation of such manufacturing processes [3], [4]. Fritzsche et al. developed several modules based on artificial intelligence to solve the high quality requirements that are needed in the fixation of automotive structures during its production cycle, as well as to reduce setup time. According to this method, each connection point in a database is determined and compared to the location previously set. The resulting value of the comparison is implemented in a system which makes position adjustment automatically through a mathematical algorithm based on neural networks. This ensures the strict positioning required by the demands of production line and customer.

The difference in properties of these materials makes it difficult to automate the process, due to the difficulty in maintaining positional rigidity. In any case, this problem is not limited to glass fibre reinforced plastic parts. The manipulation of bent wires usually used in the metallic structure of seats for car industry presented similar problems, whose have been was recently studied by Magalhães et al. In this case, the steel wires have different mechanical properties, which provides complete randomness in the direction in which the wire moves when it has just been cut [5]–[7]. Given the asymmetry presented by a large part of the forms which these wires must ensure, and the need to put them in a well-known position to be subsequently used by the following process - plastic injection - automatic equipment has been developed to ensure position. Due to the random positioning, it was necessary to use artificial vision to circumvent the problem. The diversity of models has often created serious difficulties for the automation of certain processes carried out essentially at the expense of labour intensive. Nunes and Silva developed an automatic equipment for the assembly of components related to widescreen wipers, in an environment embedded in great diversity of models. This diversity of models is accompanied by a great diversity of shapes, which are difficult to accommodate in a single automatic system. With the aid of automatic vibratory feeders and ingenious positioning and routing systems, it was possible to automate this assembly operation, reducing cycle time by 36% and ensuring much higher quality levels. The labour force allocated to the process was also significantly reduced [8]–[10]. A similar study was developed by Costa et al. A fully automated system was developed, where labour is only necessary for logistics operations to supply components and remove assembled parts. In this case, the body of the pieces was plastic, unlike the case, where the bodies of the main pieces were metallic. A completely automated adjustment is possible in, so the setup time is insignificant and the quality of the final product is guaranteed. Once again it was used vibrating feeding systems and ingenious guidance and positioning systems, allowing the proper assembly of a varied range of parts belonging to the same family. The cycle time has been shortened and quality control has been ensured through artificial vision. In order to improve quality in the manufacture of components for motor vehicle tires, Santos et al. developed a new concept for one of the stages of tire construction. In this case, an upgrade is designed to improve the process, reduce downtime due to malfunctions, improve operator safety, and shorten setup time. Through a new methodology to approach this multi- variated problem, and with the aid of automation, it was possible to drastically improve the equipment, realizing that all the objectives were achieved. On the other hand, Moreira et al. studied the automation of a process of assembly of drive cables for motor vehicles, normally used for the opening of doors, engine cover, trunk lid, opening and closing of windows, etc. The new concept of assembly equipment of these components for the automotive industry has drastically reduced the workforce allocated to this task, ensuring a higher level of quality and a reduction in setup time and cycle time. At the same time, the equipment has a very high versatility, allowing to handle a vast set of cables of the same family. It should be noted that the equipment allowed to aggregate a set of operations that were carried out in different equipment until then [11], [12].

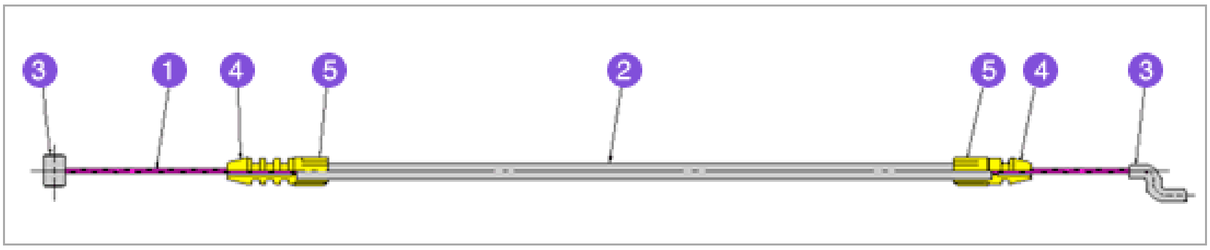
The work here presented aims to extend the knowledge about how to automate another task related to the same product, but where it is necessary to integrate grease. This lubricating grease aims to improve the sliding of the metallic cable inside the plastic sheath where it is inserted, as well as to protect the metallic cable against corrosion phenomena. The assembly corresponds to a component called a control cable, which performs the functions previously described in a car. In the literature, no study was found to solve problems of this nature. The development of this work aims at establishing and disseminating some guidelines on how to overcome problems related to this operation, such as: wastage of time, standardization of the task throughout the fleet of machines, facilitate logistical supply operations and avoid wastage of lubricant grease, with the consequent damage to the environment and to the competitiveness of the process.

METHODOLOGY

Several companies are committed to designing control cables for the most complex motor vehicle drives. Figure. 1 An example of a control cable is shown. Such cables 'performance is directly related to the lubrication between the metal cable (1) and the coating thereof. The lubricant minimizes the friction between these two components which allows the cable to move quickly, smoothly and easily, thus conditioning its performance. There are some benefits of using greases in the control cables. They can dampen mechanical vibrations and have a higher permanence capacity in the area, attenuating the leakage problems associated with the lubricating oil. We also reduce wear via long-term action which increases the cable life significantly. Specific formulated lubricants can have especially low friction coefficients, which contain various anti-wear additives, antioxidants, which corrosion inhibitors.

The approach used in this work consisted of the following phases: problem analysis, the drawing up of the list of criteria and the design of an integrated solution that would solve the waste grease problem.

Fig.1: Example of a Simple Control Cable.



*(1) Inner cable, (*2) Outer casing, (3) Cable end, (4) Casing cap (5) Clamp.

Problems Identification:

The research was created to solve a problem posed by a firm that has 38 lines of grease injection in control cables, as shown in Fig. 2. Each of these devices has a grease tank, which is pumped into the cable by means of an injection needle (Fig. 3) and pneumatic cylinder action. The grease goes through several measures, before being inserted into the cable. The lubricant is shipped in buckets to the client, which may have different dimensions, and will be stored in the logistics warehouse. Then, these buckets are placed in a mobile device (Fig. 4) to be transferred to the injection line to fill the reservoir. The grease supply is done on most injection lines using this mobile app. Some injection lines, however, have a fixed unit, directly attached to the injection line, which contains the grease bucket and the components needed to fill the reservoir. With this set in the injection line the filling of the reservoir is done because its removal is something complicated and time consuming. Moreover, if not coupled to their injection line, the reservoirs have no system that prevents grease leakage through their outlet port.

Fig.2: Injection line with Coupled Reservoir

Fig.3: Lubricant Injection Needle

Fig.4: Reservoir Filling Device

This cable lubrication system has several problems. It presents great waste of grease because the equipment used does not allow an efficient extraction of the mass of the bucket. This waste translates into a cost to the company and a loss to the environment. In injection lines with no fixed filling device the operator has to move to the specific place in the production area where the mobile device is located and transport it to the line which needs to fill the reservoir. After filling the reservoir, the operator must return the mobile device to the initial location. This is a time-consuming and difficult task, due to the distances that need to be travelled and the weight of the device itself that has to be moved manually. In addition, it is necessary to connect the reservoir to the mobile device and wait for it to be filled to continue production. This procedure for filling the reservoirs implies, of course, a lower productivity of the injection lines. Another problem is poor lubrication of the cables, due to the introduction of air during the injection of the grease, which can cause a decrease in its efficiency and durability, and may also imply customer complaints.

Requirements for the lubrication system:

The lubrication device must meet the following specifications:

a. Reduce grease waste by creating a system that allows complete or almost complete grease extraction from the buckets and also allows the use of buckets of various sizes.

b. Reduce the injection lines stopping time for supplying grease to the reservoirs;

c. Reduce issues caused by inadequate cable lubrication when inserted into the cable due to the presence of air in the grease;

d. Minimize the expenditure needed for the above changes to be implemented.

RESULTS AND DISCUSSION

The solutions suggested in this section for improving the lubrication of the control cables and meeting the above requirements are described in a concise and simplified way.

The work included a number of measures covering the whole method of processing, shipping and handling grease tanks, as well as fitting the reservoirs through the cables to the grease filling device. Furthermore, since certain issues with air intrusion were also identified as a problem affecting the consistency of the final product, an air detection system was developed that would avoid air injection along with the grease.

For the extraction of the mass from the bucket, and consequent filling of the reservoirs, the system was developed, which should be located in the logistics warehouse. In this solution, where it is possible to supply up to four reservoirs simultaneously, it is the reservoirs that have to be transported to the filling system. The changes introduced into the reservoirs to facilitate their removal and attachment to the injection line, as well as their transport, are presented later. This system has a platform

(1) For supporting and fixing the bucket

(2) As well as all the components necessary to extract the mass from the bucket and its injection into the reservoirs, previously placed in the filling bench

(3) The positioning and fixing of the bucket on the platform is achieved by three claws with concentric movement, and separated from each other by an angle of 120º.

The claws are fixed on skids that slide along guides, whose rail size depends on the maximum diameter and minimum diameter of the buckets used in the company. The clutch actuation is performed by a pinion/rack system driven by a pneumatic cylinder. The grease is extracted from the bucket through a hole previously opened in its lower part, and by the action of a metal disc. This disc, whose diameter depends on the inner diameter of the bucket, has a rubber edge that allows an adequate contact with the side walls of the bucket, in order to minimize the wasted grease, i.e., the mass quantity which remains to be extracted from the bucket. For the vertical movement of the disc, two pneumatic cylinders (4) are used, avoiding the use of a pump, making the solution more economical. At the bottom of the platform, coincident with the bucket hole where the grease is extracted, there is a mechanism that promotes the injection of the lubricant into the reservoirs on the filling stand. The lower part of the platform, where the mechanisms of clutch actuation and injection of the grease for the reservoirs are found.

CONCLUSION

The device developed in this work for the injection of grease, in control cables for the automotive industry, clearly expands previously existing information about this form of industrial process, allowing for the fulfilment of proven environmental goals and preparing the industrial structure for future automation, in line with what is widely referred to as the 4th industrial revolution. Moreover, this definition enables the incorporation of many operations which have so far been interpreted as complex, greatly enhancing the management of one or more production lines. The definition, as well as being applicable for this specific activity field, can be easily generalized to other industrial sectors where similar problems cause perturbation of production line yields and environmental harm. Therefore, this novel definition can be described as allowing:

a. Reduce grease waste that represents a expense to the business and damage to the environment. This goal is accomplished by adjusting the disc that facilitates grease extraction from the bowl. In addition to the proposed scheme, which allows many reservoirs to be filled, the grease found in a bucket is used quicker and more thoroughly, eliminating the induced waste and related environmental contamination;

b. Using seals with various dimensions. On the frame that supports the bucket, the claw mechanism enables bucket fastening with various diameters.

c. Quickly and conveniently disassemble and assemble reservoirs along the injection lines;

d. Fill up to four reservoirs simultaneously, without stopping the injection lines. Reservoir filling process is done outside of the injection lines;

e. Simple storage of grease reservoirs and empty reservoirs from the lines of injection;

f. Transport the reservoirs through the company to supply grease reservoirs for the injection lines and collect the reservoirs that have completed their operating period using a normally used milk-run system;

A prototype of the cables mass injection system including the air detection system was made. The system performed as planned so the concept could be tested and repeated to the other company-owned equipment. The transport network is still in manufacturing process. The framework built through this research demonstrates how technological advances can be combined fairly with a manufacturing sector's logistics management systems, enhancing their performance in both competitive and environmental terms. This research applies scientific expertise for the automotive industry in this specific field of cable control manufacturing, but can be extended to other forms of industry where the use of lubricants contributes to production management issues and environmental concerns. Furthermore, this program is ideal for centralized and automated management and can be implemented into a 4.0 model for industry.

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