

CONCEIVING AND IMPLEMENTATION A WORKSTATION

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ABSTRACT: The paper presents the realization of a reconfigurable final work station, namely the last post in a manufacturing line. In order to achieve the final station of a product, should be known well the product (in this case a voltage converter used in the car), the assemblies and checks that are made on the manufacturing line on the final station, the station's ergonomics and possible problems that could come from the manufacturing line. The next step is to choose materials with ESD (electrostatic discharge) properties to make the final station because we use electrostatic charge sensitive materials. Choosing the pneumatic and mechanical drive components that lead to the manufacturing of the electric control panel is the next issue. It is important that the operator performs fewer actions, so he is more efficient and less tired at the end of a working day. The steps of the paper: presentation of the work object, mechanical designing, practical realization of the final station, problems encountered in the initial phase and way of solving.

KEYWORDS: the "final station", 3D model, car component, scanner support system, assembling

1. INTRODUCTION

A work line involves a certain number of workstations, where different operations will be performed, depending on the product you want. There are a lot of operations and processes that are running in these factories. But if these processes are varied and differ from product to product, absolutely all production lines need a particular station, the "final station".

It exists in different forms, names, but it will exist, being the last station in the production line. Even if some operations were checked at the previous stations, if they were correctly executed or not, the final checks are made to ensure that the product complies with the requirements and can be sent to the customer.

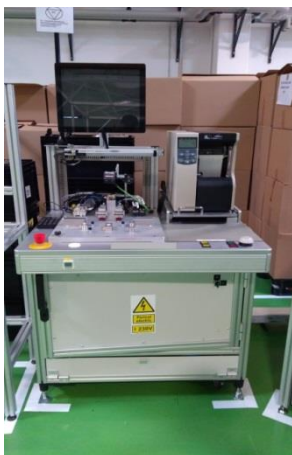


Figure 1. Final station for the «DCDC Converter» product

The first step in building such a workstation is a discussion between everyone who will take part in designing and then assembling it. It is necessary to determine what the station must do and the order of operations to ensure a normal working pace for the operator and to observe the time required for these operations.

2. PRESENTATION OF THE WORK OBJECT

We will give a final station example for the «DCDC Converter», product a car component that will turn 12V into 24V, figure 1.

2.1 Mechanical designing

In order to begin mechanical designing, it is set what standards must be respected. The ergonomics standard of the workstation, like height, width and depth are set.

Then the materials are set. In general, aluminum and stainless steel are used because they are materials with ESD (electrostatic discharge) properties. Then, because the product has to be stuck on the work table, the locking methods are discussed. Due to the fact that an electrically operated mechanical locking system presents risks in terms of maintenance and operation in optimal parameters, a pneumatically driven mechanical lock is chosen.

Here the automation engineer will look for and choose the required cylinders with the amendment that they can be operated at a pressure of 0.5 bar so that there is no risk of injury to the operator if the product is blocked and to stop automatically when

checking the pins if they are bent. The automation engineers will also choose the sensors needed to check the product's presence, cylinder status, and the presence of the vent plug. It has come to the conclusion that for the cylinders an end-of-travel sensor will be used, for the presence of the product an inductive sensor with a very short range of action, and for the presence of the vent plug, a laser sensor is suitable.

To begin designing, it will need the 3D model of the finished product.

This will be obtained by the industrialization department. After obtaining it, it will be discussed with the process engineer who will be in charge of this production line, in which position the product will have to be placed on the worktop in order not to introduce extra movements for the operator because these movements will turn into lost time, which will affect the performance of the line.

Once this has been established, the designer will place the product on the drawing in the indicated position, following only a few ergonomic distances, so as not to force the operator to movements that affect his / her health. The engineer's work has been greatly improved due to the construction standards.

Thus, he will already have the skeleton design of the station and several other already designed parts. To reach this level with the design, he will receive from the automation engineer and from the programmer engineer the 3D models of the cylinders, sensors and scanner used, to be introduced in the project. In this case, the first problem was the choosing of the scanner.

Due to the way the product is handled and how it will be placed on the work table and the place where the labels will be placed, it is necessary to choose a particular type of optical scanner. After several variants, a Keyence scanner was chosen to ensure all the required conditions. After choosing of the scanner the sensors and the cylinders the actual work starts, designing the mechanical parts, figure 2.

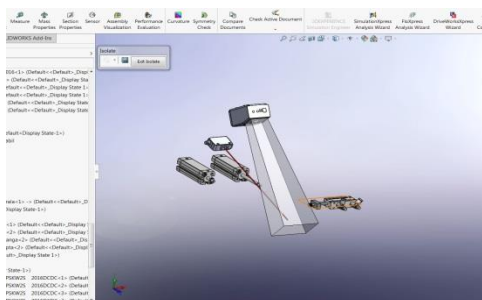


Figure 2. Designing the mechanical parts

Special attention is needed here because many pieces will have imposed tolerances. First, a set of

calibrated pins will be designed to check the sizes of the holes in the product. The next step is the mechanical design of the locking system. The locking will be done with some mechanical parts passing over the edges of the product. At this time the product is seated and locked on the work table.

The next phase of the design requires (figure 3) special attention because the gauges will be designed to check the pins alignment in the connectors of the product. All gauge holes will have tolerances of a few hundredths of a millimeter, depending on pin and connector construction tolerances in conjunction with the quality department requirements. Mistaken quotation of these gauges will result in either declaring good products as NG (not good) or sending faulty products to the recipient. None of these variants is viable.



Figure 3. Design requires

The next step is to design an adjustable scanner support system.

After all these are designed, a design review session will be carried out with all those involved in the construction of the station, plus an engineer from the industrialization department and one from the production process. At this meeting it is established whether the design meets the requirements. If everything is ok, the programmer engineer will describe the operating steps of the machine, how and where the signals will be taken and which commands will operate each.

Once everything has been established, the design engineer will switch to 2D drawings to run the parts. Depending on the complexity, the size, the number, and the availability of the company's internal tools, they will either be done internally, which is a financial economy for the firm or will be done by one of the external collaborators.

3. PRACTICAL REALIZATION OF THE FINAL STATION

After receiving the mechanical parts, the workstation assembling is started. Even if the technicians will be involved in the actual assembling, this operation will be performed under the direct supervision of the design engineer.

When the final station is assembled, the software and the graphical interface will be implemented (figure 4). In parallel, the sensors and the scanner will be calibrated.

After the station is assembled, the sensors are adjusted and the installed software is prepared the initial acceptance of the equipment is performed (figure 5). This involves putting the station in operation and following the working steps with a certain number of products - 30,40,50 - depending on the different companies, to see if everything is working normally and to fix the problems if they occur.

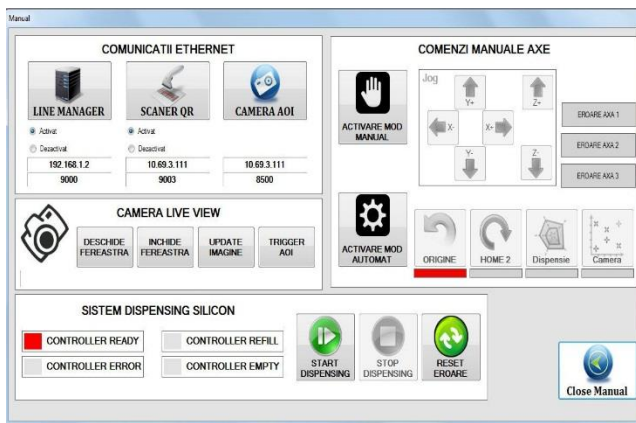


Figure 4. The software and the graphical interface



Figure 5. Command buttons

According to the specifications received from the industrialization department, this station will check: the size of the holes, the existence of the "product label", the presence and correct insertion of a piece, called "vent-plug" two connectors and then the correct application of a "customer label".

4. STAGES OF INITIAL ACCEPTANCE

It has come to the conclusion that the first step will be to place the product on the worktop. Then it will be stuck in the position it is in, then check for the existence of the "product label". The next step will be checking the presence of the vent-plow and the alignment of the connector's pins.

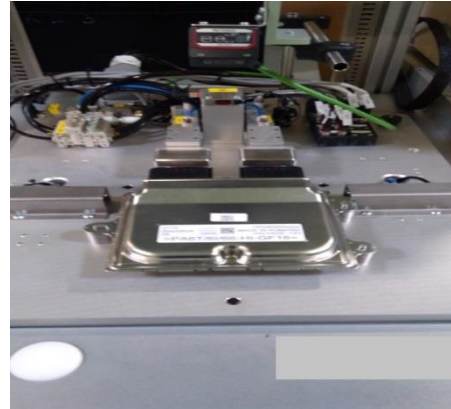


Figure 6. Release of a customer label by a printer

The last step is the printing of a customer label by a printer (figure 6), sticking it on the product by the operator and then stamping it if it is properly located and written.

To verify the labels and release a label from the printer, the programmer engineers will be responsible. They will also be in charge of executing the station's work program and integrating the interface. It is set to use an optical scanner, which should be chosen according to the reading distance and field of view required, dimensions that will be given by the design engineer.

4.1 Problems encountered in the initial phase

Since the first tested products there have been some problems. First, the gauges did not enter into connectors. Second, the scanner was reading one label of 3. Third, it was noticed that the safety system does not cover all the situations that may occur in the production process. In addition, not all products have the proper holes drawing the product so that some cannot be placed on the work table. Because the time is limited, the acceptance audit is done with the recipient at a well-established date and solutions are being sought.

The problem with the holes is a problem which does not depend by the construction of the product, these holes coming non-aligned from another manufacturer. This assumed the intervention of the industrialization department to request derogation from the beneficiary and to no longer do this checking. They agreed because, after some simulations, it turned out that the size of these holes does not have a critical dimension. Therefore, by the

internal tool shop the guiding pins were changed by thinning them by 0.5 mm.

A brainstorming was made about the safety issue, which highlighted all the situations that would require an emergency stop of the station. Following this session, the software has been modified to cover all issues.

Unfortunately, the other two problems were worse so their solving required more efforts. If the label was not read, it came to the conclusion that it is because the place where it is placed is not bound by anything, so the operator can place it in different places, and the scanner does not read it. The beneficiary was contacted and the solution of making small shaping of 90 degrees angles to delimit the application area was proposed (figure 7). Once this has been approved, this change without affecting the operation of the product has been sent to the supplier of that component.

The suppliers made the changes of the component according to our specifications, but this took quite a long time, so the deadline was approaching and we did not know if we had time to do the necessary checks. Finally, the supplier made it in time so this problem has been resolved.



Figure 7. The application area

The most delicate problem was the gauges. To find out the cause of a problem, different standardized systems are used giving good results most of the time. After a careful analysis, it was discovered that the physical model of the connector differed pretty much from the 3D model. These differences were caused by the injection of the material into the matrix, by the design of the connector, and some other features.

We contacted the beneficiary proposing to modify the matrix to produce a viable connector and in accordance with the product design requirements. This puts into balance the price and the term of execution of this modification of the matrix with the impact of the lack of modification and what does it means. Taking into account that the physical change does not influence the quality of the product, the

beneficiary did not agree with the modification of the matrix.

As a result, the connector was sent to the 3D measurement department, where it was measured, and the size measurements went back to the design engineer. He repaired the 3D model of the gauges and they were sent to the grinding. All these operations took a long time.

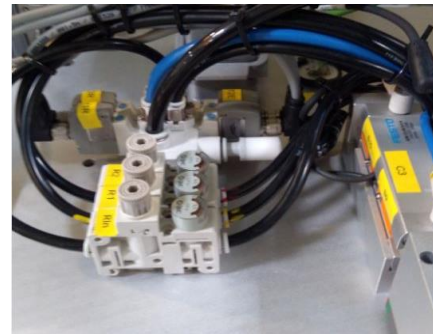


Figure 8. The connector

After rectification, tests were performed again, with a remarkable improvement, but the automatic calibration system was still giving a lot of errors, which was not acceptable, the error rate needing to be 0.

Analyzing the situation again, it was observed that for some products, the angle of the connector relative to the integrated board, although it should have been 90 degrees due to the connector's imperfection, sometimes has a difference of 0.5 degrees (figure 8). To solve this, the first variant was the change of the pressure with which the cylinders were actuated. By changing the pressure from 0.5 bar to 2 bars, the problem has disappeared and the gauges entering in the connectors very easily.

Unfortunately, it was not a viable solution, because the designer realized that a pushed caliber with a pressure of 2 bar would definitely not stop when it encounters a bent pine but it will break or will bend it though the end-of-travel sensors on the cylinder will indicate that everything is ok and this way there is a great deal to get a defective product to the customer.

Finally, the solution was found by designing a simple, spring-based self-centering system. Although in most cases it is not advisable, this time it was the correct solving of a pressing problem.

All the problems being solved, the acceptance audit with the beneficiary was a success, as the production line could start the mass production at the date of the contract.

However, there are still some issues to be solved before the production goes into production.

Execution of a working documentation with the station components, included on a stick and their drawings, inventory with pneumatic parts, sensors, electrical, etc. so that the maintenance knows exactly what type of piece and what code it will have to change if it will fail (figure 9).



Figure 9. The workstation prototypes

In addition, the documentation will include the software's working steps and where and how to intervene in case of problems. At the same time, a file will be added to solve problems that have occurred so far in other stations, so that the technician or maintenance engineer can solve the problem as soon as possible and the line can produce with less downtime.

After the completion of all works, the team that worked on the construction and putting in operating position of the station, will discuss the problems that have arisen during this time and will try to find solutions that can be applied to the next project, so that it will proceed without incidents.

5. CONCLUSIONS

Making a manufacturing line for the manufacture of converters, which has a final station, involves a very high production cost of the order (about 100 million Euros). Using 3D design in a 3D graphics program saves a substantial amount of money.

Saving at the design stage is important because it allows for keeping quality by using more expensive components in the practical realization phase. Another major problem is the possibility of verifying the final product as easily as possible.

In the case of sales of a poor-quality product due to the components used it does not suffer the one who manufactures the control and drive components but the company that makes the machine or the production line. As we have seen in the paper, another difficult task to follow is the relationship

between the departments and the clear division of each person's duties.

The realization of the final station was done at the request of the beneficiary, even if there were problems with some tolerances of realization.

The design system shown in this paper shows that a station on the manufacturing line can easily be changed when a new product is introduced, as the time of use of a product is getting more and more shorter.

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