

# Design Control Systems of Human Machine Interface in the NTVS-2894 Seat Grinder Machine to Increase the Productivity

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**Abstract.** In the Manufacturing of automotive spare parts, increased sales of vehicles is resulted in increased demand for production of engine valve of the customer. To meet customer demand, we carry out improvement and overhaul of the NTVS-2894 seat grinder machine on a machining line. NTVS-2894 seat grinder machine has been decreased machine productivity, the amount of trouble, and the amount of downtime. To overcome these problems on overhaul the NTVS-2894 seat grinder machine include mechanical and programs, is to do the design and manufacture of HMI (Human Machine Interface) GP-4501T program. Because of the time prior to the overhaul, NTVS-2894 seat grinder machine does not have a backup HMI (Human Machine Interface) program. The goal of the design and manufacture in this program is to improve the achievement of production, and allows an operator to operate beside it easier to troubleshoot the NTVS- 2894 seat grinder machine thereby reducing downtime on the NTVS-2894 seat grinder machine. The results after the design are HMI program successfully made it back, machine productivity increased by 34.8%, the amount of trouble, and downtime decreased 40% decrease from 3,160 minutes to 1,700 minutes. The implication of our design, it could facilitate the operator in operating machine and the technician easier to maintain and do the troubleshooting the machine problems.

## 1. Introduction

This research was conducted in a company engaged in the manufacture of Automotive Spare Parts valve engine for the purposes of motor vehicle engines. Valve engine manufacturing process are generally consists of forging, satellite welding, heat treatment, and machining. Increased sales of vehicles resulted in increased demand for production of engine valve of the customer. Referring to this, the company plans to conduct the addition of 1 new line bringing the total Machining Line that there be 18 lines. In addition, The Company is also does improvement or overhaul on some machines. Under these conditions, we do the overhaul and improvement. One machine overhaul is performed the NTVS-2894 seat grinder for the seat grinder on machining line 7. Overhaul is based on the growth of developing technology and also because of the addition of lines in the area of machining lines. Improvement made on human machine interface in the absence of back-up program HMI NTVS-2894 seat grinder also to facilitate the operator to operate the seat grinder machine.

In our previous researches [1-3], we have designed and analysis the various sensor applications on the machine automation PLC-based in manufacturing industry, and also using the HMI (Human Machine Interface). We have designed automatic control system according to the working specification to improve the working efficiency of the machine, time reduce of the machine trouble,



the addition of pokayoke system sensor (early warning error detection), and modification of control system in manufacturing machine [4-7]. Relatively our new research is control systems modification in height lever checker machine using the laser sensor. G. Valencia-Palomo et al. have design an auto-tuned predictive control based on minimal plant information using PLCs [8]. Putman et al. have design virtual fusion by integration virtual components into a physical manufacturing system [9]. While Buhrer et al. have discussed about changeability of manufacturing automation systems using an Orchastration Engine for PLCs [10]. Milik have discussed about PLCs control program hardware about mapping and scheduling [11].

In this paper, we design and manufacture the human machine interface program. The advantage is that the company does not have to pay for the services HMI programming and also the advantages of using HMI that allows an operator in operating machines as well as facilitates the troubleshooting to minimize lost production time due to the operation and troubleshooting the machine by operator and maintenance. We design how do communicate Human Machine Interface GP-4501T with PLC and how to design a program of the Human Machine Interface GP-4501T of the seat grinder machine. In addition, we also design how to facilitate the operator in operate machine and maintenance in do troubleshooting; accordingly trouble and downtime on the NTVS-2894 seat grinder machine is decline and impact on enhancement productivity machine.

## 2. Methods

### 2.1 Seat grinder machine

Seat grinder machine is a machine that is in the area of machining process. Seat grinder machine is a machine that uses a grinding stone as media process works. Millstone that used is NORTAKE GRIND 510 x 12 x 20 2 CX100R. Seat machine grinder is in machining section. In the seat grinder machine, part processed valve is part of the valve seat. The results of the processing valve which have a standard, owned by the valve. The following are the standard that must be considered after going through the process on the Seat Grinder machine: the dimensions of the distance from the seat to the tip end; seat angle; seat run out; seat roundness; and seat roughness.

Dimensions and tolerances of the seat grinder machine are micron; consequently it very high precision. If one of the dimensions is not in accordance with the standard of tolerance, the valve will be declared not good (NG). Figure 1 shows the NTVS-2894 seat grinder machine.

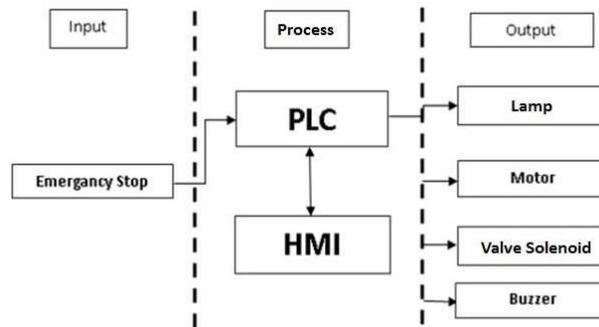


**Figure 1.** The NTVS-2894 seat grinder machine.

## 3. Results and Discussion

### 3.1. Control system design

Figure 2 shows control system design that includes: input, output, and the process of PLC.



**Figure 2.** Control system design.

### 3.2. Process control system

3.2.1. *PLC.* In this design, PLC serves as the control center that controls output based on input received either from the operator or sensor. In the design of PLC as a control center not only process the data in the form of digital data but also PLC process data in the form of serial data. Binary serial data in the form of numbers, Hexadecimal, Decimal, or Text are sent via the serial communication in the form of a serial cable that is communicated to the HMI Preface.

3.2.2. *HMI.* HMI is used as an intermediary between the users (in this case the operator) with the machine. So users can interact well with machine, it means the HMI makes it easy for users to operate the machine and know the system is in progress. HMI communicating is using two-way serial communication that can transmit data in the form of binary, hexadecimal, decimal, and text.

### 3.3 Part input

3.3.1. *Emergency stop button.* Emergency stop button is used to stop the machine or cycle off when the trouble or unwanted circumstances.

### 3.4 Part output

3.4.1. *Lamps.* Lamps are used for indicators related to the engine. To be used as an indicator lamp and lamp power master on.

3.4.2. *Motor.* The motor is used as the driving of the spindle, and oscillations in the engine as well as a driver for playback millstone.

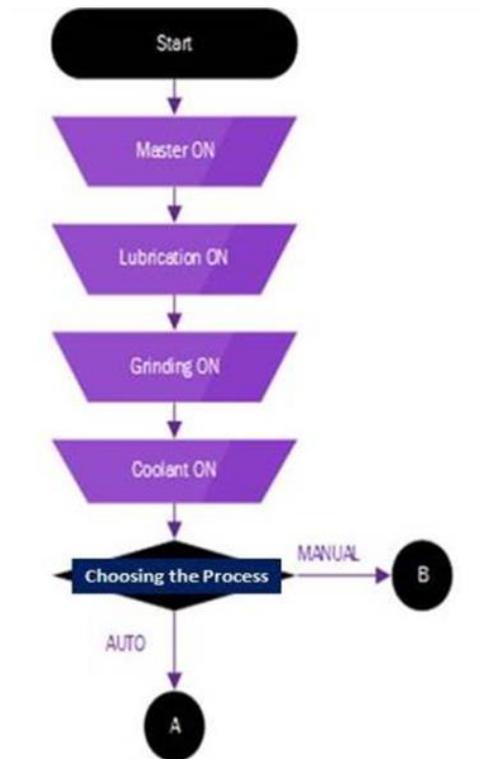
3.4.3. *Solenoid Valve.* Solenoid valve is used as the driving piston. Both for forward and backward.

3.4.4. *Buzzer.* Buzzer is used as a warning sign in the form of sound when there is trouble on the engine Seat Grinder NTVS-2894.

### 3.5 Design of the programming

Before design a program in advance, we create a flow program of the seat grinder machine. Here will be explained how the diagram flow or process flow from the NTVS-2894 seat grinder machine. Flow process on the NTVS-2894 seat grinder machine consists of a flow process preparation, flow process manually, and the process flow Auto. Here is an explanation of each process flow that exists on the NVS-2894 seat grinder machine.

3.5.1. *Preparation of process flow.* Process flow preparation in which the operator presses the master key on, engine life was marked with monitors HMI lights up, after the operator pressed the buttons on HMI start of lubrication on to oscillation on and selects the auto or manual. Figure 3 shows the process flow preparation.



**Figure 3.** The process flow preparation.

3.5.2. *Auto process flow.* When the operator presses the Auto button on the HMI, then the NTVS-2894 seat grinder machine works automatically. But the requirement to begin the process of auto first pressing cycle on that machine will work automatically. After pressing, cycle on feeding machine will proceed automatically, by starting the gate off the chuck open later ejector forward and ejector backward then loader down the clamp open after the pusher forward and finger down and then chuck close later pusher backward and spindle on and finger up the loader up and then the gate open and close clamp. When the process is finished, the spindle off and re-started from the gate off.

3.5.3. *Manual process flow.* When select a manual process, then process the NTVS-2894 seat grinder machine will work manually. Conditions typically used to perform the manual setting process of the machine. When the maintenance or cleaning and while there is a problem. On this manual process each sequence is controlled by a button on the HMI. For example cylinder that serves as a loader, loader will be open or closed will have its own button on the HMI and so did the other sequences.

**3.6 Design of HMI programming**

The design of the HMI control program of the NTVS-2894 seat grinder machine is based on the design of component specifications and designs that have been made. The design of this HMI programming is in accordance with the work process of the NTVS-2894 seat grinder machine. The HMI program that we use is GP-Pro software version 4.0. Figure 4 shows the screen preparation of HMI programming.

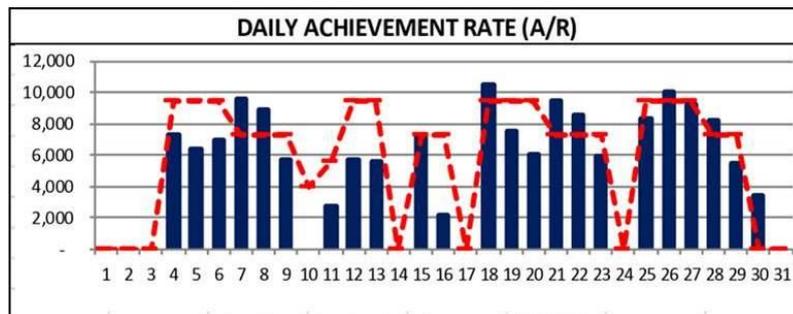


**Figure 4.** Screen preparation.

*3.7 Results analysis*

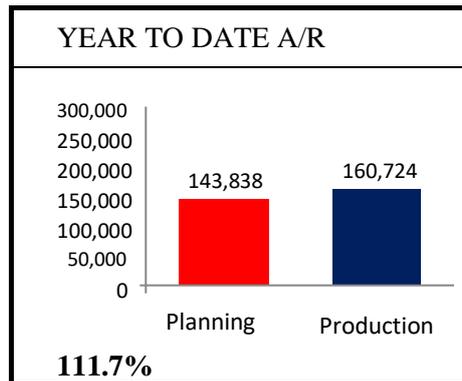
*3.7.1. Machine Trouble.* One of the causes of the overhaul on the NTVS-2894 seat grinder machine is due to trouble on the NTVS-2894 seat grinder machine to reach 176 times troubles. With 18 months with 176 times of troubles, average the NTVS-2894 seat grinder machine has trouble of  $\pm 10$  troubles per month. After the overhaul of the NTVS-2894 seat grinder machine, the amount of trouble on the NTVS-2894 seat grinder machine is decreased. With the decrease of the amount of trouble on the machine it also affects the downtime of the machine. The downtime of the NTVS-2894 seat grinder machine has decreased. The decreased of downtime machine is 1,700 minutes, from the previous is 3,160 minutes.

Figure 5 shows the production achievement of the NTVS-2894 Seat Grinder machine every day for a month. The red line is production target and the blue bar is production actual.



**Figure 5.** Achievement of the production.

The total of valve production on the previous NTVS-2894 Seat Grinder machine is 160,724 pcs per month, with a production target is 143,838 pcs per month. Thus, the actual machine production capacity exceeds a predetermined target. Figure 6 shows the total Achievement of Production.



**Figure 6.** Total achievement of production.

### 3.8 Discussion

One benefit after overhaul is to optimize the performance of the NTVS-2894 seat grinder machine. Production data before the overhaul, NTVS-2894 seat grinder machine has production achievement of averaged only 77% per month of total production targets. After the overhaul, machine production reached 111.7% calculated in the first month of the production. So the achievement of this machine production increased by 34.8%. Further program development can be done in accordance with work function, to meet production needs, for maintenance, and for machine repair.

### 4. Conclusions

In this paper, we have discussed about the design control systems of Human Machine Interface in the NTVS-2894 seat grinder machine to increase productivity, to decrease trouble and downtime of the machine. For Pro-Face HMI communicates GP-4501 T (Analog) with PLC is using RS-232 cable D-sub 9-pin and design Human Machine Interface programming covers the main screen and alarm screen with use GP-Pro EX software ver. 4.0. After do overhaul and modification system control, the HMI occurs productivity machine increased 34.8% from 77% to 111.7%, declining trouble from an average of 10 times per month. The downtime on the NTVS-2894 seat grinder machine decline of 3,160 minutes is 1,700 minutes. It could facilitate the operator in operating machine and the technician easier to maintain and do the troubleshooting the machine problems. In addition, for the future research, further program development can be tailored to the operator's work function and to meet changes in production targets, machine maintenance, and machine troubleshooting.

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