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Graphic Interface Applied to the front Suspension Assembly Process for Automobile

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Abstract- This paper proposes a graphical interface to be integrated into the physical architecture that has been established to receive a specific process of assembling the front suspension to the automobile. The physical architecture contains many cells with the necessary means to enable workers to carry out assemblies of various types of suspensions. In the development of the graphical interface are considered means for defining the formal sequence of assembly of each type of suspension in order to increase the production capacity and decrease losses by undue assemblies. The layout set for virtual components and also the choice of resources are planned to increase the expressiveness and ease of use of each window contained in the graphical interface. The validation of the operational features of the graphical interface is obtained by carrying out practical tests on a prototype that uses the basic elements that are specified in the aforementioned physical architecture.

Keywords: graphical interface, front suspension assembly, automobile.

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GRAPHICINTERFACEAPPLIEDTOTHEFRONTSUSPENSIONASSEMBLYPROCESSFORAUTOMOBILE

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Graphic Interface Applied to the front Suspension Assembly Process for Automobile

Francisco C. P. Bizarria[α], José W. P. Bizarria[σ], Rogerio Oliveira de Paula[ρ] & Ariadne Arrais Cruz[ω]

Abstract- This paper proposes a graphical interface to be integrated into the physical architecture that has been established to receive a specific process of assembling the front suspension to the automobile. The physical architecture contains many cells with the necessary means to enable workers to carry out assemblies of various types of suspensions. In the development of the graphical interface are considered means for defining the formal sequence of assembly of each type of suspension in order to increase the production capacity and decrease losses by undue assemblies. The layout set for virtual components and also the choice of resources are planned to increase the expressiveness and ease of use of each window contained in the graphical interface. The validation of the operational features of the graphical interface is obtained by carrying out practical tests on a prototype that uses the basic elements that are specified in the aforementioned physical architecture. The positive results observed in practical tests suggest that the graphical interface will be able to increase productivity in the front suspension assembly process for automobile.

Keywords: graphical interface, front suspension assembly, automobile.

I. Introduction

The current scenario of the global economy establishes a condition in which the industries have to invest financial resources in the production lines to overcome seasonal variations of production demands that are imposed by consumer markets and also to maintain adequate quality standards, reduce losses in production, minimize lead times, lower costs and increase flexibility in manufacturing [1].

The management of a multinational company to meet the characteristics of the global economy and also keep the jobs, promoted the study to develop an assembly line of the front suspension for automobiles in order to supply the Latin American market.

The preservation of jobs is the requirement that aims at minimizing the social impact within the community in which the company operates, and improve local trade and also the infrastructure and also the and also the infrastructure as a whole. The very high initial financial cost was another important factor considered to limit the level of automation for production line.

In this context, this work proposes a graphical interface to be integrated into the physical architecture that has been established to receive a specific process of assembling the front suspension to the automobile.

The physical architecture was designed with many cells to meet production line. Each cell contains the necessary means so that a single worker performs assemblies of various types of suspensions that are produced by the company.

In developing the graphical interface are established every means to assist the worker who uses the resources of the physical architecture in conducting formal sequence to assemble each type of suspension in order to increase production capacity and reduce losses due to improper assembly.

The layout set for virtual components and also the choice of resources are planned to increase the expressiveness and ease of use of each window contained in the graphical interface by the worker.

The validation of the operational features of the graphical interface is obtained by carrying out practical tests on a prototype that uses the basic elements that are specified in the aforementioned physical architecture.

II. Objectives of the Work

The aim of this paper is to present a proposal for a graphical interface to be integrated into the physical architecture that has been established to receive a specific process of assembling the front suspension to the automobile.

Present the first results that were obtained on the practical tests performed with the prototype that adopts the basic elements contained in the aforementioned physical architecture.

III. Physical Architecture

Figure 1 shows the principal components of a production cell that belongs to the physical architecture that has been established to receive a specific process of mounting the front suspension to the automobile.

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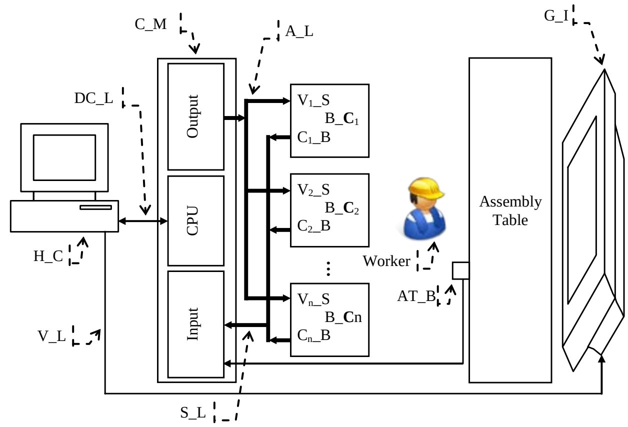

Fig.1: Physical architecture of the cell.

The acronyms contained in the physical architecture that is shown in Figure 1 have the following meanings:

a) Host Computer (H_C).
b) Graphical Interface (G_I).
c) Video Line (V_L).
d) Data Communication Line (DC_L).
e) Control Module (C_M).
f) Sensor Line (S_L).
g) Actuators Line (A_L).
h) Box Components (B_C).
i) Visual Signal (V_S).
j) Component Button (C_B).
k) Assembly Time Button (AT_B).

The function of the Control Module (M_C) can be performed by a Programmable Logic Controller (PLC) that is equipped with Central Processing Unit (CPU) capable of controlling the inputs and outputs, digital and / or analog, working with wide range amplitudes and frequencies of electrical signals [2].

In Control Module (C_M) is loaded the software that performs the management of the main activities planned for use of resources of the physical architecture [3]. The software performs all tasks in accordance with the parameter setting sequence which was held for the assembly of each type of suspension, including the activation of alarms and signals required for the process in question.

All control module outputs uses the Actuators Line (A_L) to control the activation of each Visual Signal (V_1_S, V_2_S, ..., V_n_S) that is installed in each Box Components (B_C_1, B_C_2, ..., B_C_n). The visual signal is activated with the purpose of assisting the worker in identifying which box has the component to be used in the present suspension assembly time. Each box components must store a single type of component that is used during assembly of the suspension.

Control module inputs receive the signals from each Component Button (C_1_B, C_2_B, ..., C_n_B) that is installed in each Box Components (B_C_1, B_C_2, ..., B_C_n), as well as the Assembly Time Button (AT_B). It is worth mentioning that the Assembly Time Button (AT_B) is used by the worker to start or stop or ending time count which is used for assembly each suspension.

The main functions of the Host Computer (H_C) are concentrated in hosting the Graphical Interface (G_I) and also make the transmission and reception of information that are related to the states of variables in the software installed on the Control Module (C_M).

The Graphical Interface (G_I) consists of several windows that should work with the resources available in the operating system of the Host Computer (H_C).

Within the windows contained in the Graphical Interface (G_I) are present virtual components that allow: access to the system, make changes, start the system, set the sequence for carrying out the assembly of each type of suspension, activate alarms and visual signals to be used during the production cycle. The Data Communication Line (DC_L) is the means that the Graphical Interface (G_I) uses to communicate with the Control Module (C_M).

IV. Prototype

A view of the prototype that was produced validate the graphical interface to be integrated on the physical architecture that has been established to receive a specific process of mounting the front suspension for the automobile is shown in Figure 2. The tests with the prototype were concentrated on the evaluation of the operational capacity of each virtual component contained in the graphical inter face.

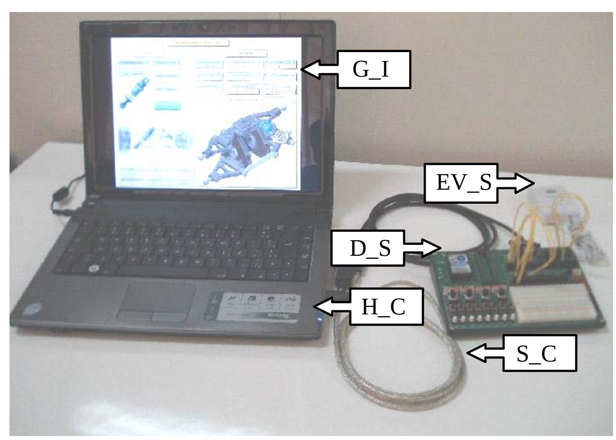

Fig.2 : Prototype view.

As shown in Figure 2, the main modules provided in the prototype are: graphical interface (G_I), host computer (H_C) development system (D_S), external voltage source (EV_S) and cable for serial communication (S_C).The number of modules contained in the prototype is lower when compared to the one defined for the physical architecture of Figure 1, but this condition is not sufficient to cause significant impact on the validation.The graphical interface (G_I) used in the prototype was developed through the resources contained in the Supervisory, Control and

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Data Acquisition (SCADA) system, that is called by Elipse SCADA [4]

The host computer (H_C) used in practical tests is the portable type (notebook) with 64-bit, Intel architecture and Microsoft® Windows 7 operating system

The development system (D_S) chosen for the prototype is called by CUBLOC STUDY BOARD 1, as the same is capable of performing the cycle as well as the processing functions that are typical for Programmable Logic Controller (PLC), and can generate and receive electrical signals that are related to the sensors and actuators contained in the physical architecture [5]

The external voltage source (EV_S) has the function to provide electric power that is consumed for operating the development system (D_S) in direct current

The cable for serial communication (S_C) is the physical means by which the development system (D_S) and the graphical interface (G_I) transfer data with each other, through communication protocols defined by Electronic Industries Alliance (EIA).

a) Management software

The information management software is designed to meet the practical tests performed with the prototype. The software considers a sequence specific activity that the worker must perform to assemble a kind of suspension.

Each step in the assembly sequence is recognized by development system (D_S) by stimuli that are applied to the digital buttons (D_B), the digital key (D_K) and potentiometers (A_P), according to the details presented in Figure 3

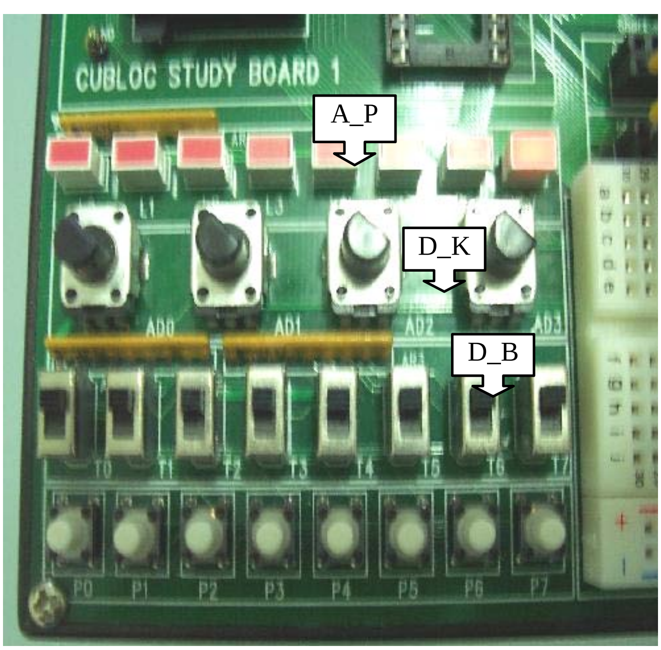

Fig.3 : Details development system.

In response to the stimuli applied to the buttons and switches, the graphical interface (G_I) presents the pictures and other details that are related to each phase of the suspension assembly sequence.

The analytical flowchart containing a specific sequence of actions foreseen in the management software that was used in carrying out practical tests of this work is shown in Figure 4

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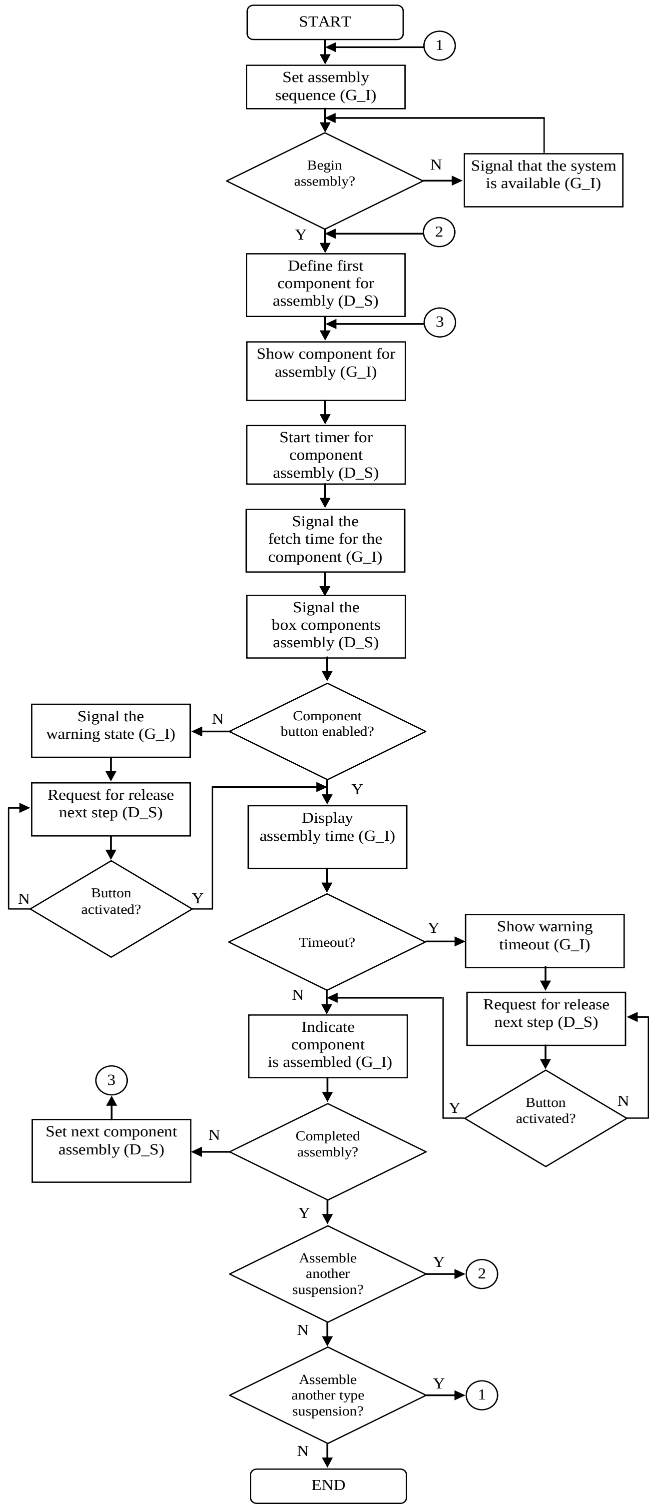

Fig.4 : Flowchart to test the graphical interface.

The acronyms contained in the flowchart shown in Figure 4 have the same meanings as those shown in the prototype view (Figure 2).

b) Graphical interface

The main function of the graphical interface (G_I) is concentrated in presenting visual signals in sufficient expressivity to assist the worker in the task of fetching items and also to assemble every suspension component. The main window of this interface is shown in Figure 5. It is worth mentioning that the figures of the suspension components used in the practice tests were obtained from the system called AUTODESK® [6].

The window shown in Figure 5 has two columns of virtual objects. The Column-1 is divided into groups which are called: FETCH, DETAILS and UTILITIES.

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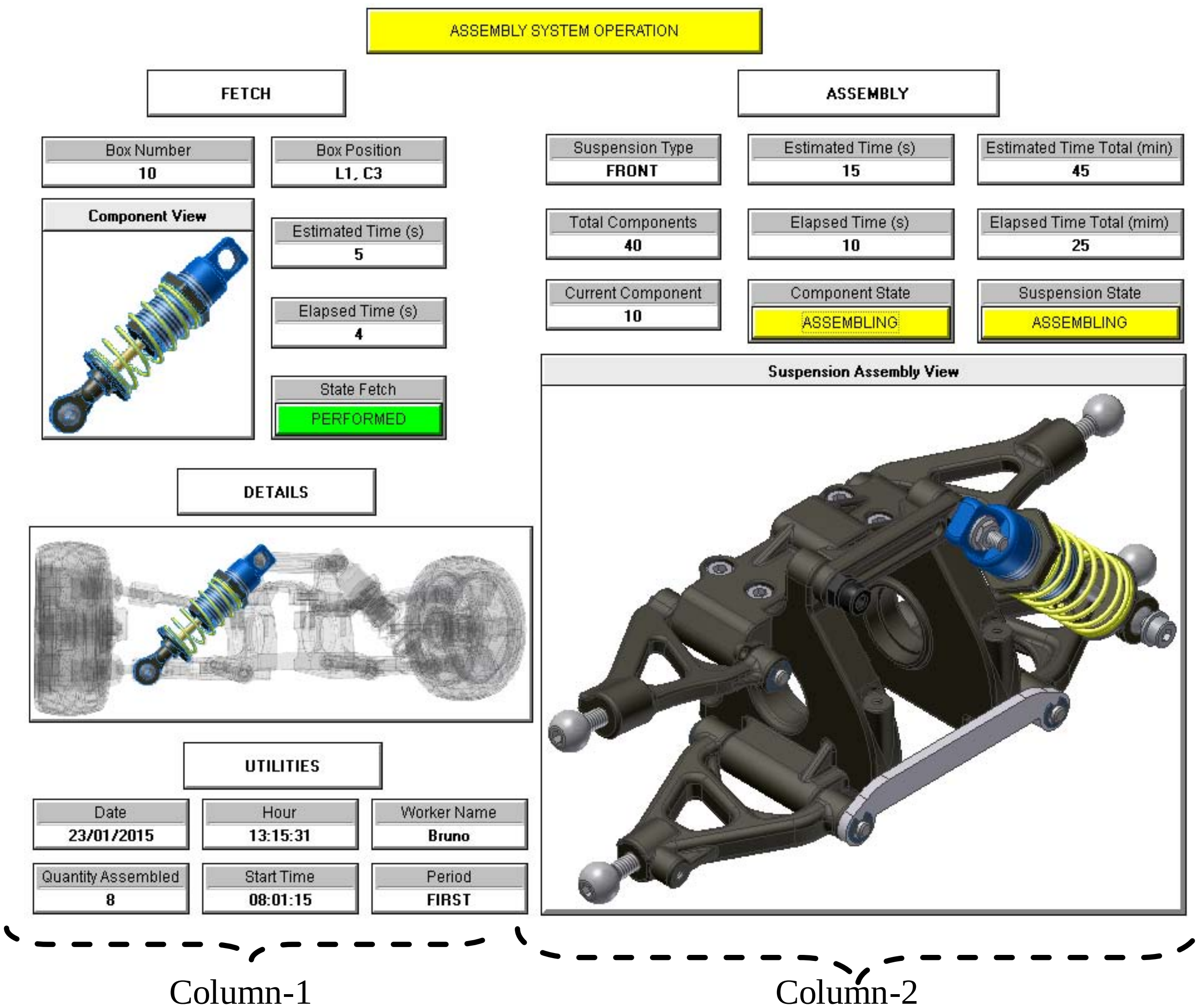

Fig.5 : Main window of the graphical interface.

The FETCH group contains means for the worker is able to identify the physical position of the box with the component to be assembled on the table, the removal of component of each component box, and also carry out the definition and measurement of the fetch time of each suspension component.

The virtual objects designed to meet the aforementioned purposes are designated:

a) Box Number.
b) Component View.
c) Box Position.
d) Estimated Time, in seconds.
e) Elapsed Time, in seconds.
f) State Fetch.

It is worth mentioning that the virtual object named by State Fetch shows the message "CURRENT", if the current step is the fetch component, and the indication "PERFORMED", if the Component Button (C_B) is activated by the worker to indicate that the fetch task was completed.

The intermediate stage between the fetch task and assembly of the component on the table is served by the DETAILS group, which may have a figure containing comments relevant to the realization of the assembly.

The additional information in the window is performed by UTILITIES group which has called virtual objects:

a) Date.
b) Hour.
c) Worker Name.
d) Quantity Assembled, this field is related to the current number of assembled suspensions.
e) Start Time.
f) Period, this field is related to the period that the worker is exercising activities in the company.

The information presented on the mentioned group are based on parameter values and obtained from the host computer (H_C).

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It is worth mentioning that Start Time and Quantity Assembled display information which are related to the time elapsed from the activity start time of the worker and the amount of suspensions assembled at this time.

The Column-2 has virtual objects related to the type of suspension, the component to be assembled, the number of components assembled on the table, the assembly time for each component, the suspension assembly time, the component assembly signaling and also signaling for assembly the suspension.

The virtual objects designed to meet the mentioned signs are called:

a) Suspension Type.
b) Total Components.
c) Current Component.
d) Estimated Time, in seconds.
e) Elapsed Time, in seconds.
f) Component State.
g) Estimated Time Total, in minutes.
h) Elapsed Time Total, in minutes.
i) Suspension State.
j) Suspension Assembly View.

Due to the importance for the successful operation of the graphical interface (G_I), the virtual object named by the Suspension Assembly View occupies the largest area; it has the function to show the figures represented in three dimensions that are related to the components mounted on the table.

c) Practical tests

The procedures adopted in carrying out practical tests related to the graphical interface (G_I) that is proposed in this paper are as follows:

a) Make the connections of the modules contained in the prototype is shown in Figure 2.
b) Develop software in ladder language for development system (D_S), which follows the steps contained in the flowchart shown in Figure 4.
c) Prepare graphical interface containing the window shown in the Figure 4.

By means of the inputs contained in the development system (D_S) that is shown in Figure 3, the set of stimuli was applied to simulate the assembly sequence of the suspension in the physical architecture shown in Figure 1.

As consequence of applied stimuli was observed that the graphical interface (G_I) at the host computer (H_C) is able to properly display the visual signals expected for that type suspension assembly.

Some of the stimuli were applied with the goal of simulating an incorrect sequence of assembly in order to evaluate the system's ability to identify this situation, which actually occurred.

The results of the practical tests were positive because the graphical interface (G_I) was able to display all the virtual components in the correct sequence to assist the worker in the assembly task of the front suspension to the automobile.

It is very important to emphasize that the simulations with the incorrect assembly of components for the suspension were identified by the graphical interface (G_I), which allows the worker to correct and execute the exact sequence.

V. Conclusions

Satisfactory results observed in practical tests show that the proposal presented in this paper is feasible and can be carried out for the application to which it is intended. The objectives planned for this phase of the study were achieved, especially with regard to propose a graphical interface to assist the development of the activities performed by the worker in a physical architecture that was established to receive a specific process of assembling the front suspension to the automobile.

The graphical interface when integrated into a real physical system may contribute to increase production, to reduce the suspension assembly time, to minimize errors and also facilitate the implementation of activities by the worker.

The layout adopted, the quantity and clarity of the virtual objects provide an intuitive and meaningful environment for the worker carry out the suspension assembly.

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