



Graphic Interface Applied to Automated System to Manage the use of Tools in Machine

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Graphic Interface Applied to Automated System to Manage the use of Tools in Machine

Francisco C. P. Bizarria ^α, José W. P. Bizarria ^σ, Luis F. de Almeida ^ρ & Fernando M. R. S. e Santos ^ω

Abstract- The processing industry has to find ways to reduce manufacturing costs, as a way to survive in the market with increasing competition. This competition has become increasingly driven by globalization, that is, an industry has to share the consumer market with other industries that are installed worldwide. One of the possible ways to reduce manufacturing costs is related to the efficient use of basic inputs. Among the main inputs used in the manufacture, some are specifically related to the tools that are installed on machines such as lathes, grinding machines, presses and others. Typically, the tools developed by the industry in the process engineering sector have dedicated characteristics that must be maintained to perform the appropriate transformation of the product being manufactured. The preservation of these characteristics is linked mainly with the specified service life for the use of each tool, in order to make the substitution before the product is affected by non-conformities arising from the manufacturing process. The tool replacement at the right time becomes essential, but to perform this task should be considered aspects related to the early and late replacement, both of which can lead to increased costs for the purchase of tools or rework parts produced with different characteristics what was envisaged in the specification. In this context, this paper proposes a graphical interface to be integrated into the physical architecture of the automated system that makes managing the use of tools for industrial eccentric press. All virtual components designed for the windows of the graphical interface are significant and related to the procedures set out to make the replacement of each of the press tool. The validation of the functionality of the interface is obtained by means of tests on the prototype that adopts the basic elements provided in said architecture. The positive results observed in practical tests suggest that graphical interface is appropriate for the purpose which it is intended.

Keywords: tool replacement, eccentric press, graphical interface, automation.

1. INTRODUCTION

In the last decades the global consumer market is demanding products with competitive cost, minimum assured quality, configuration options, ease of maintenance, durability, ergonomic advantages, sustainability ecological characteristics consistent with diversified

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social values, and free of exploitation with human labor and/or animal in the manufacturing process [1].

In order to meet these characteristics, national and international industries are investing in the improvement of their manufacturing facilities and adopting the use of automation in their production lines as the main resource to: i) maximize the control performed at the various levels of the process, ii) to integrate production lines, iii) to reduce losses in the process, iv) to increase manufacturing capacity, v) to meet seasonal variations in production demands, vi) to minimize the number of production cycles, vii) to meet national and/or international standards; and viii) to reduce or even eliminate the use of human and/or animal labor in repetitive tasks and/or environments that are hostile and/or dangerous [2].

In this sense, the manufacturing industry also has to look for effective ways to reduce manufacturing costs as a way to survive in a market with growing competition. This competition has become increasingly stimulated by globalization, as an industry has to divide its consumer market with others installed in different parts of the world.

One of the possible ways to reduce manufacturing costs is related to the efficient and effective use of basic inputs. Among the main inputs used in manufacturing are those related to the tools that are installed in machines, such as: lathes, grinders, presses and others related. Typically, tools developed by an industry's process engineering sector have dedicated features that must be maintained to perform the proper transformation of the product being manufactured.

The preservation of these characteristics is mainly related to the useful life that is specified for the use of each tool, in order to replace them before the product is affected by non-conformities from the manufacturing process. The replacement of tools at the right moment becomes essential, but in order to perform this task, the aspects related to premature and late replacement must be considered, both of which may generate cost increases for tool acquisition or rework in parts that were produced with divergent characteristics.

In this context, this work proposes the use of a graphical interface to be integrated in the physical architecture of the automated system that performs management in the use of tools for an eccentric industrial press. The virtual components elaborated to

meet the windows of the graphical interface are expressive and related to the procedures defined to carry out the replacement of each tool of the press. The validation of the functional efficacy of this interface is obtained through tests carried out in prototype which adopts the basic elements provided for in architecture.

II. OBJECTIVES OF THE WORK

This work has as main goal to propose the windows and their respective virtual components for a graphical interface to be integrated in the architecture of automated system that performs the management in the use of eccentric press tools, in order to minimize the premature or late replacement of these tools.

To present the most expressive results obtained in the practical tests carried out with the prototype that was developed to validate the virtual resources contained in the windows of the mentioned interface.

III. REFERENCE ARCHITECTURE

The basic blocks provided in the physical architecture that is considered as reference to integrate the resources established in each window of the Graphical Interface (GI) in order to interact with the automated system that manages the use of tools in eccentric press are presented in Figure 1.

The acronyms defined for the blocks contained in the reference architecture, which is shown in Figure 1, have the following meanings: i) HC: Process Engineering Host Computer or Tool Preparation Room, ii) GI: Graphic Interface of Process Engineering or Tool Room, iii) TDB: Tool Database, iv) DCL: Data Communication Line, v) DPC: Dedicated Press Control, vi) CMP: Control and Monitoring Panel, and vii) EP: Eccentric Press.

The block called Host Computer (HC), which belongs to the Process Engineering Sector, has the following main functions: i) host, at the application layer, the window of the Graphical Interface (GI) that allows the system user to register the codes of the products that will be manufactured by the press, the codes of the tools available to meet the processes and the useful life times established for operations under nominal press conditions, in Tool Database (TDB), and ii) perform data communication with the Dedicated Press Control (DPC) and Host Computer (HC) of the Tool Preparation Room. The Dedicated Press Control (DPC) block has features that allow: i) to execute the Eccentric Press (EP) operational control algorithm, ii) to parameterize the Eccentric Press (EP) operating modes, iii) to control, monitor and interrupt the operation of the Eccentric Press (EP), through the local Control and Monitoring Panel (CMP), iv) send signals to control the actuators installed in the physical structure of the Eccentric Press (EP), v) receive signals from the installed sensor systems in the physical structure of the Eccentric Press

(EP); vi) to perform data communication with the Process Engineering Sector and the Tool Preparation Room.

The resources contained in the Host Computer (HC) of the Tool Preparation Room are directed to: i) host, at the application layer, the Graphical Interface (GI) window that allows the user to access the records that are registered in the Tool Database (TDB) for up-to-date information on the quantities of tools available, product codes, tool codes, and service life of each tool, ii) selecting and loading specific tool data in the Dedicated Press Control (DPC) to be used in the current manufacturing process, and iii) to perform data communication with the Process Engineering and Dedicated Press Control (DPC).

The Data Communication Line (DCL) is the physical means established to perform data communication, in a bidirectional way, with the Host Computer (HC) that belongs to the Sector of Process Engineering, Computer Host (HC) from the Tool Preparation Room, and Dedicated Press Control (DPC). It should be mentioned that this line is provided with galvanic separation and protection against electromagnetic interference.

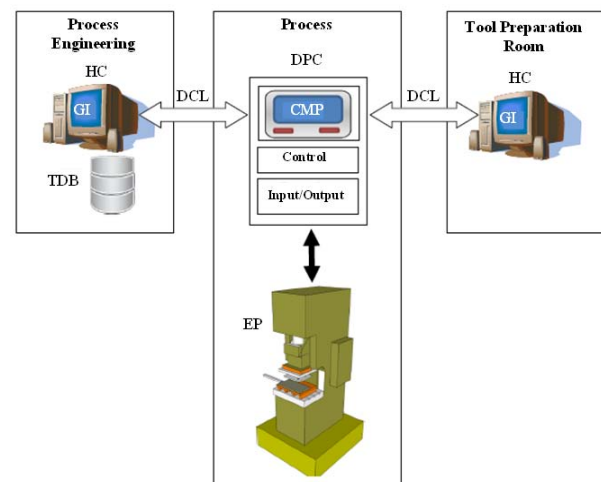


Figure 1: Reference Architecture Blocks.

In the Eccentric Press (EP), each production tool is installed, which should have its life cycle monitored to identify the appropriate moment of substitution, in order to avoid the negative consequences related to premature or late exchange.

IV. PROTOTYPE

A view of the components contained in the prototype that was assembled to evaluate the features established in the Graphical Interface (GI) windows, which is intended to be integrated into the physical architecture of the automated system that performs the management in the use of tools for an industrial eccentric press, is shown in Figure 2. In this prototype

the practical tests were carried out to validate the operational efficiency of the blocks of the reference architecture shown in this work, with special attention being given to the elaboration, operation and use of the virtual components that are contained in the windows of said interface.

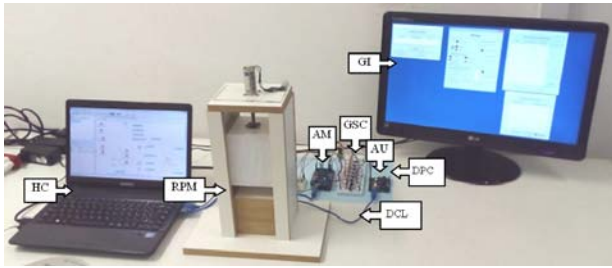


Figure 2: Prototype view.

As shown in Figure 2, the components established for the prototype are: i) Graphical Interface (GI), ii) Host Computer (HC), iii) Data Communication Line (DCL), iv) Dedicated Press Control (DPC), and v) Representative Press Model (RPM). It should be mentioned that the number of modules defined in the prototype is lower than that predicted in the reference architecture shown in Figure 1, but this condition is not limiting to prevent the validation of the virtual resources that are present in the Graphical Interface (GI) windows.

The Host Computer (HC), used in the prototype, is a portable (notebook) type, with Intel® 64-bit architecture and Windows 8.1™ operating system. The Graphical Interface (GI), installed on this computer, has been developed with the resources available in the integrated development environment that is called by MyOpenLab, build: 3.0.4.1, under license: GNU - general public license [3].

In the physical layer, the Data Communication Line (DCL) adopts the EIA (Electronic Industries Alliance) 232, and in the logic the protocol denominated by Firmata [4].

The Dedicated Press Control (DPC) consists of: i) microcontrolled unit (AU) of the Arduino type UNO [5], ii) Galvanic Separation Circuit (GSC), and iii) micro-controlled unit (AM) of the Arduino type MEGA 2560 [6].

The Arduino UNO unit (AU) performs the bidirectional data communication interface between the Galvanic Separation Circuit (GSC) and Host Computer (HC), through the protocol Firmata.

The Galvanic Separation Circuit (GSC) is a mean established to perform bidirectional communication of electrical signals between the Arduino UNO (AU) and Arduino MEGA 2560 (AM) unit in an irradiated way. It should be mentioned that the use of this circuit is intended to minimize possible incompatibilities and/or electrical faults of one unit affecting the operation of the other.

The purpose of the Arduino MEGA 2560 (AM) unit is to: i) execute the dedicated operation control of

the Representative Press Model (RPM) from the command signals sent by the Galvanic Separation Circuit (GSC), and ii) send signals related to the state of the sensors installed in the Representative Press Model (RPM) for the Galvanic Separation Circuit (GSC). This unit is equipped with a specific circuit to control the motor installed in the model, which is the Motor Shield L293D Driver H-Bridge [7].

a) Management software

In the development of the prototype, a version of the tool management program was developed for an eccentric industrial press in order to evaluate the virtual resources that were established for each Graphical Interface (GI) window. In this sense, the analytical flowchart that represents a specific sequence of actions foreseen in this management program, and that was used in the accomplishment of the practical tests of this work is presented in Figure 3.

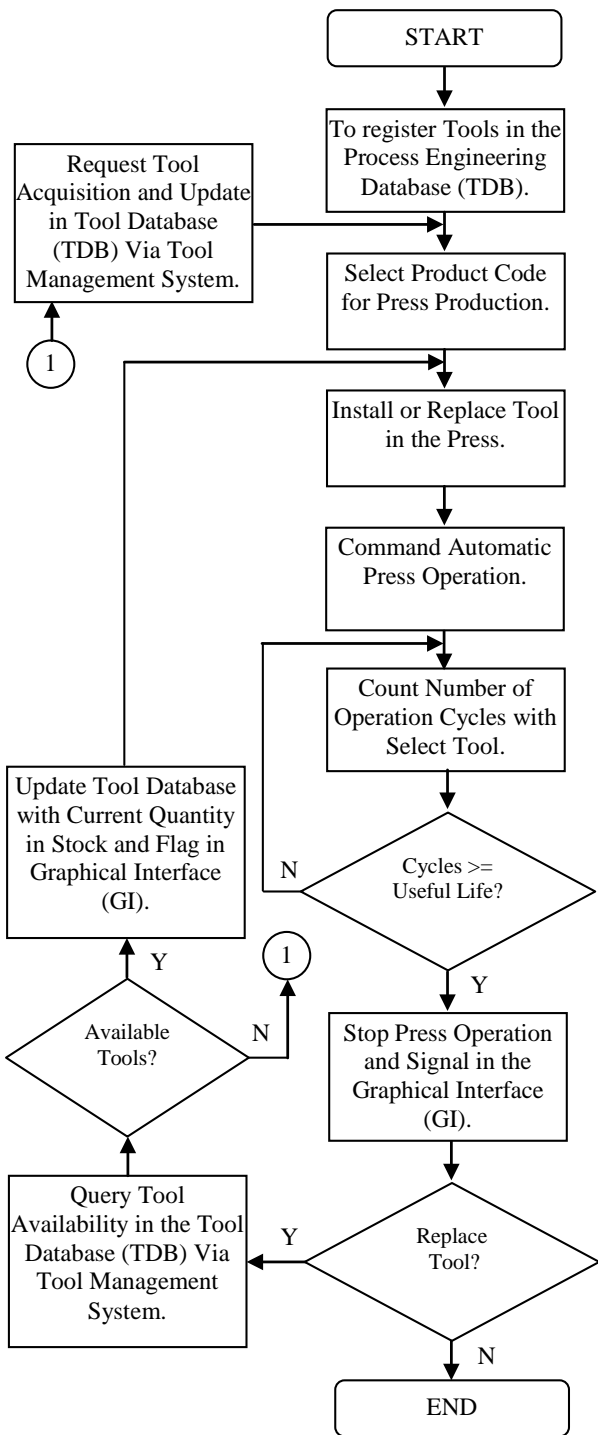


Figure 3: Flowchart of the management system.

b) Graphical interface

In the windows of the Graphical Interface (GI) that was elaborated for the prototype are present the resources that allow to the user of the system to make the registrations of the codes of the products, codes of the tools, times of useful life and also, to carry out the control, the monitoring and the interruption of the operation of the Representative Press Model (RPM).

In this sense, Figure 4 presents the virtual resources that were established for the Tool Registry

Window, which specifically serves the Process Engineering Sector.

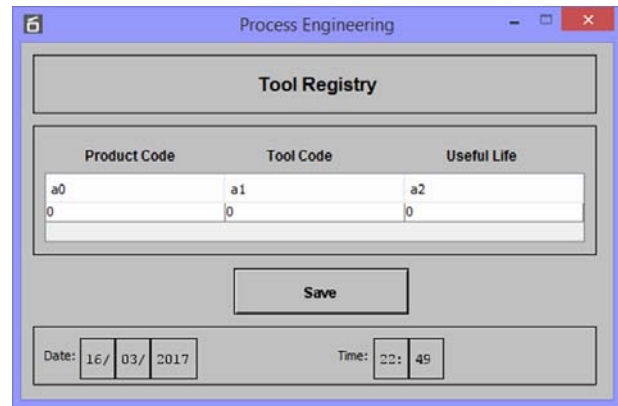


Figure 4: Process engineering tool registry window.

The virtual components contained in the Tool Registry Window, shown in Figure 4, allow the Process Engineering user to perform the following tasks:

- Enter each product code number in the field labeled "Product Code", where this field establishes the product that will be manufactured in a specific production process by the press.
- Register each tool code in the field called "Tool Code", this field contains the code defined by the company for each tool that is used by the press in its various manufacturing processes.
- Register each tool life in the field called "Useful Life", this field establishes the useful life for each tool that is used in the press in nominal use condition.
- Save in the Process Engineering Sector Database (TDB) the information that has been registered through the Tool Registry Window.
- View the current date (Date) and time (Time), which are provided by the Host Computer (HC).

The Figure 5 presents the virtual resources that were developed to attend the Press Window, which is dedicated to the production process. In this window there are regions with virtual components that allow the production user to perform the following tasks:

- Set the automatic mode (Automatic) or manual mode (Manual) of the press by means of the virtual key contained in the region that is called Press Condition. The manual mode is basically used to carry out tool replacement in the press or set the initial state of the actuator (Ready Press) to set the reference in the automatic operation.
- Execute the production cycle for the press using the button labeled "On/Off Cycle", which is present in the region called "Auto Mode Functions". When this button is activated the visual signaling that is called "On Cycle" will be activated (red color) and the one called "Cycle Off" will be inactive (black color), and the button in the not activated state will occur vice versa. It should be mentioned that in this region

visual signals are also present to indicate that the actuator of the press is in the condition of maximum retracted (Press on top) or maximal expanded (Press on bottom), since the set formed with the sequences of activations of these signals defines the Cycle of the tool.

- Establish a reference to start the operation of the press (Referencing Press) with the resources contained in the region called "Manual Mode Functions". The user can actuate the button labeled "Jog Up Press" to set the maximum condition retracted in the actuator of the press, or "Jog Down Press" for the maximum extended condition. When these buttons are activated the visual signage called "Jog" is activated.
- Manage the useful life of the tool installed in the press with the resources of the region called "Management Tool Life". The "Tool Life" display shows the current number of operating cycles that the tool installed in the press has performed, and related information is also displayed in the bar graph as another means to sensitize the user about the importance of that number to the process. The "Tool Limit" display shows the number of operations that was established by Process Engineering to use the current tool installed in the press. The "Tool Code" display shows the number assigned by the company to the tool installed in the press. The "Tool Change" signaling is triggered (red) when the current number of tool operation cycles (Tool Life) is equal to or greater than the number of operations that has been established by Process Engineering (Tool Limit), being that for this condition the operation of the press will be stopped until the replacement by a new tool, and the actuation of the button called "Tool Replaced".
- View the current date (Date) and time (Time) provided by the Host Computer (HC).

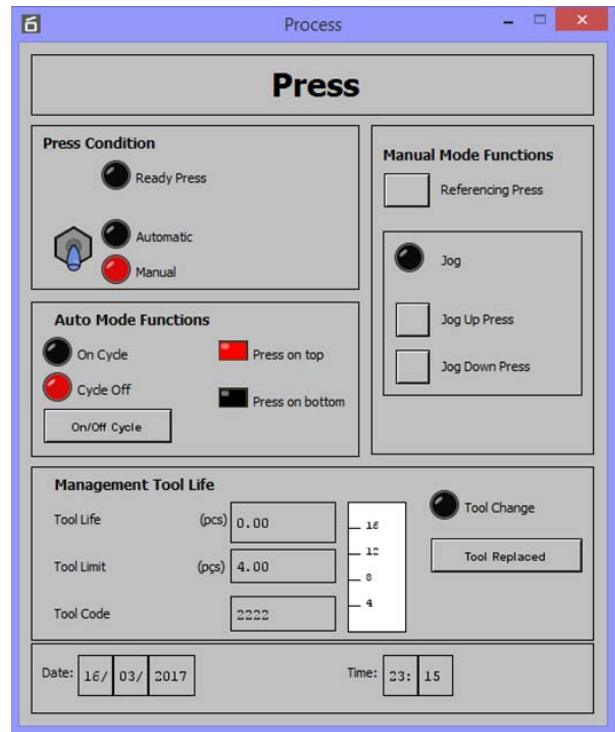


Figure 5: Press window of the production process.

The Figure 6 presents the virtual resources that have been established to serve the Tool Selection Window, which specifically serves the Tool Preparation Room.

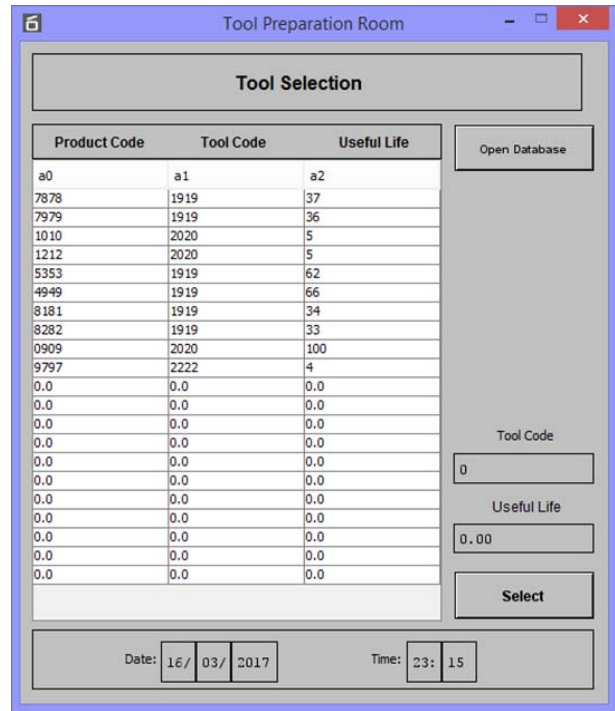


Figure 6: Tool selection window.

The virtual components contained in the Tool Selection Window, shown in Figure 6, allow the Tool Preparation Room user to perform the following tasks:

- Display the information of the product code number in the field labeled "Product Code", the tool code in the field called "Tool Code", and the tool useful life in the field called "Useful Life", which are displayed in the columns in the main part of that window.
- Update the records of tools carried out by Process Engineering, through the button called "Open Database".
- Select a particular tool to process through the button labeled "Select". It should be mentioned that the user after choosing the tool and pressing the "Select" button, the information about this tool is loaded in the respective fields of the region named "Management Tool Life", which belongs to the Press Window.
- View the current date (Date) and time (Time) provided by the Host Computer (HC).

The Figure 7 presents the virtual resources that have been developed to meet the Tool Stock Window, which is dedicated to the Tool Management System.

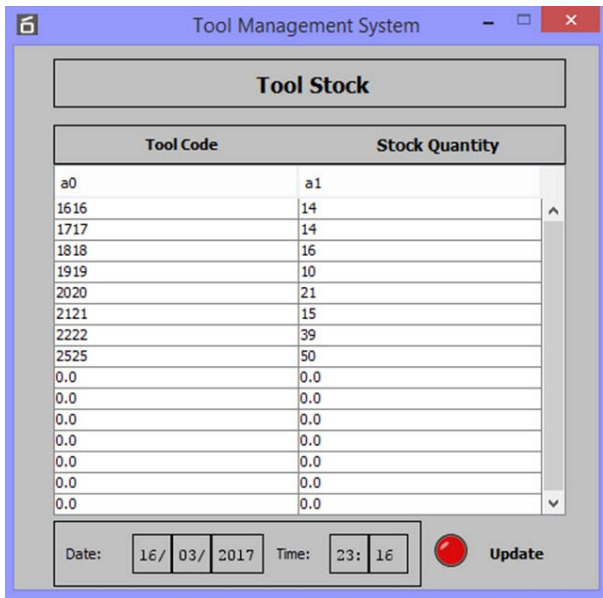


Figure 7: Tool stock window.

In the Tool Stock Window, shown in Figure 7, there are virtual components that allow the Tool Management System user to perform the following tasks:

- View information about the tool code in the field called "Tool Code", and the current number of tools available in the company stock in the field called "Stock Quantity", which are displayed in the main display columns of that window.
- View the state of the signaling that informs the update (Update) of information in the Tool Database (TDB).
- View the current date (Date) and time (Time) provided by the Host Computer (HC).

c) Practical tests

The following sequence of actions was performed to evaluate the effectiveness of the virtual components provided in the Graphical Interface (GI) windows that is proposed in this work:

- Perform the mechanical assemblies and electrical connections required to meet each of the components provided in the prototype shown in Figure 2.
- Program the Arduino UNO (AU) and Arduino MEGA 2560 (AM) units, in accordance with the respective proposals for use and the steps established in the analytical flowchart shown in Figure 3.
- Design the Graphical Interface (GI) with windows, layouts of virtual components, resources and structural hierarchy, as shown in Figure 4, Figure 5, Figure 6 and Figure 7.

The execution of the practical tests was divided in three stages, in the first one were evaluated specifically the resources related to the Tool Registry Window. This step evaluated the effectiveness of the resources provided in this window in allowing the user of the Process Engineering Sector to register the tools according to the standards adopted by the company.

In the second step it was observed whether the records registered in the Tool Registry Window were updated in the Tool Database (TDB) and available for selection in the Tool Selection Window of the Tool Preparation Room.

In the third stage the operation of the Representative Press Model (RPM) was activated, through the Press Window, in order to observe the capacity of the virtual components of this window in signaling the appropriate moment to carry out the replacement of the tool used in the current manufacturing process of the press. In this sense, Figure 8 shows the signaling activated when the current number of tool operation cycles (Tool Life = 4) is equal to the number of operations that was established by Process Engineering (Tool Limit = 4), stopping the cycle of the Representative Press Model (RPM).

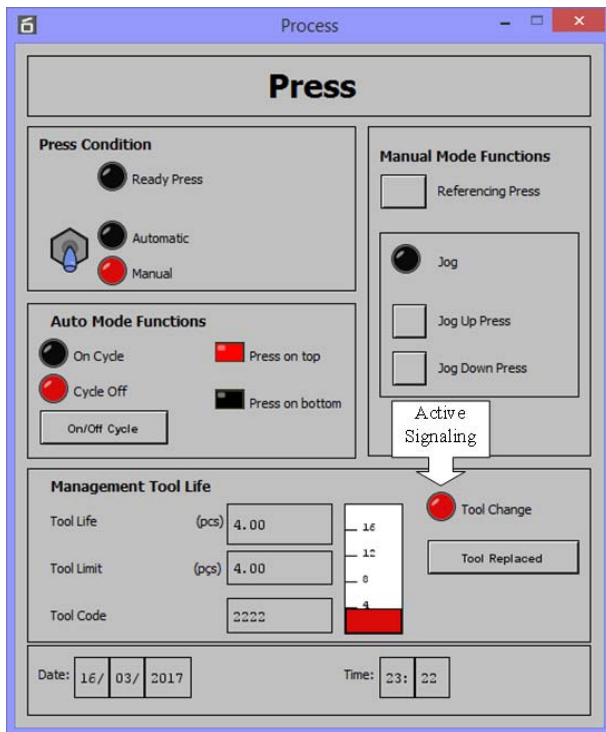


Figure 8: Signaling for tool replacement.

d) Results

The results observed in the practical tests were positive, because, with the virtual components established for the Graphical Interface (GI) windows, proposed in this work, it was possible to perform the tool registry, the selection of a specific tool to attend a given process, and the identification of the appropriate moment to perform the tool replacement, that is, the moment in which the useful life of the tool (Tool Life) is equal to the number of operations established for it (Tool Limit).

V. CONCLUSIONS

The positive results obtained in the practical tests suggest that the Graphical Interface (GI), when integrated into the real system that performs the management in the use of tools for an eccentric industrial press, may be able to aid a tool registration a selection of a specific tool to attend the process and, mainly, an identification of the appropriate moment to make the replacement of the tool in order to minimize the consequences from the premature or late tool replacement.

The virtual features contained in the Tool Selection Window and Tool Stock Window allow the user to view up-to-date information that are stored in the Tool Database (TDB), which minimize the possibility of errors in estimating available quantities of tools in the company stock.

The layout, expressiveness and details contained in the virtual components that were developed for

the Graphical Interface (GI) windows provided an intuitive and informative environment for the user of the Process Engineering Sector and the Tool Preparation Room to carry out their respective activities in the company, which collaborates to minimize the occurrence of operating errors in the use of the tool management system.

REFERENCES RÉFÉRENCES REFERENCIAS

1. Arun, S., Rajendra, S. and Bongale, V. "Automatic Punching Machine: A Low Cost Approach", International Journal of Advanced Mechanical Engineering, Volume 4, Number 5 (2014), pp. 509 - 517.
2. Rosário, J. M. Princípios de Mecatrônica, Editora Person Prentice Hall, São Paulo, Brasil, 2005.
3. Gutiérrez, J. M. R. MyOpenLab - Versión 3.010 - Guía de Usuario. URL: http://www.myopenlab.de/downloads/Guia_usuario_MyOpenLab_3010.pdf. Vis ita do em: 10 de abril de 2016.
4. Steiner, H.C. Firmata: Towards making microcontrollers act like extensions of the computer, NIME09, June 3-6, 2009, Pittsburgh, PA, 2009.
5. Banzi, M. Getting Started with Arduino, Second Edition, Published by Make: Books, an imprint of Maker Media, a division of O'Reilly Media, Inc. 1005 Gravenstein Highway North, Sebastopol, CA 95472, 2011.
6. Ozer, J. and Blemings, H. Practical Arduino: Cool Projects for Open Source Hardware, Distributed to the book trade worldwide by Springer-Verlag New York, Inc., 233 Spring Street, 6th Floor, New York, NY 10013, 2009.
7. Margolis, M. Arduino Cookbook, Second Edition, Published by O'Reilly Media, Inc., 1005 Gravenstein Highway North, Sebastopol, CA 95472, 2012.

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