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Development of Automotive Fuel System Maintenance and Educational Applications

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Abstract - It is well known that mechanical systems require procedures, supervision and maintenance, and in the era of the Internet of things and its automated age, it finds many solutions for maintenance in various applications, and maintenance and maintenance services management is currently presented as an important factor with regard to the competitiveness of companies operating in the automotive industry and the labor market due to this The level of importance to the fact that the measures taken at this level have a direct relationship to costs, deadlines and the quality of maintenance, as the study sought to design a Mica Tron system designed using the programmed electrical and electronic parts and mechanical parts in order to perform automatic maintenance of cars in the engine fuel cycle and improve the quality of work within centers Maintenance Cars and employing the results in developing the maintenance and repair course for third-grade students in industrial secondary schools, the three-year system - the specialization of cars:

- Designing a new and improved system for the maintenance process that reduces time and cost compared to the maintenance operations followed in assigning the car companies under consideration.

- Reducing time and cost, which are customer concerns.

- To achieve an increase in customer satisfaction with the maintenance provided to them.

- Increasing the productivity of maintenance operations in the companies and industrial establishments under study.

Key Words: *Inspection Robots, Skills Performance, Maintenance Operation, Automated Maintenance, Maintenance Components, Dynamic model, Auto-Maintenance Centers, customer Satisfactory, Expectation, Descriptive Analytical Method.*

1. INTRODUCTION

The maintenance function is considered one of the issues worthy of attention and research, due to the importance of maintenance work, but it did not find the magic that attracted the book towards marketing or research jobs in the various administrative fields. This is important when we find unsafe production processes, interruptions in production times, or disruptions in the dynamics. Maintenance goes through different stages of development, with the beginning of the Industrial Revolution and until recently, the common method of maintenance was a reaction method, meaning that when the machine broke down, we repaired it. The maintenance concept was: repair the machine if it breaks down. The tremendous revolution in the field of technology has led to an increase in knowledge and its use in various fields in an era that can be described as the information age and knowledge explosion, which led to the emergence of many technological innovations.

Continually increasing, and the era in which we live has become the most brilliant of the ages, so the issue of developing maintenance operations has become a great deal of concern for countries that seek to catch up with progress, maintenance is a task that has some important differences from the commonly chosen tasks and when industrial robots emerge, start looking towards developing operations The traditional maintenance of cars by workers in industrial centers and institutions for cars to a programmed automatic maintenance that works to identify faults using modern devices in detecting car malfunctions and work to implement. Maintenance required for automobiles with programmed systems to reach more dynamic and less predictable environments than is the case for many automobile industrial enterprises, where the cost benefits of automated maintenance differ from other benefits as robots usually pay their costs over their entire operational life , Maintenance has become the process that maintains the required state of the system and is something to be followed in various countries of the world because it helps to raise productivity and achieve quality. (Osama Al-Mardi Suleiman, 2010,230) defined maintenance as discovering faults, diagnosing them, then repairing them or replacing the idle parts and then Ensure that the repair is completed by all available means to confirm the quality of repair and calibration on the

available quality standards. (Frederick et al. Explain that maintenance includes) three main activities: inspection, planned maintenance, and disturbance management (where disturbances are unplanned system states). Inspection is the activity in what information about the condition is being monitored to allow for the prediction or early detection of disturbances, planned maintenance is the activity in which the elements of the system are modified or replaced according to a predetermined schedule, with the aim of avoiding or reducing the recurrence of disturbances, disturbance treatment is the activity that is performed In it, the modification or modification of the elements of the system has been replaced to restore the required state after a disturbance. Achieving customer satisfaction and creating a competitive advantage in global markets depend to a large degree on The services provided to these markets, therefore, the principle of focusing on the production process is one of the important strategies Adopted by most industrial organizations, where this strategy is based on the organization of devices, equipment and strength Working around the process of reducing the chances of loss, which reflects on the process in a positive way and makes it flexible and scalable To respond to the changing desires of customers and thus achieve an increase in productivity and improve the quality of the organization, It is something that all industrial and service organizations work for alike.

(Al-Taie, 2009, p. 201) As it requires achieving automatic maintenance in auto maintenance centers and industrial establishments, developing the performance of all workers in these centers, heads and subordinates, because they are the main starting point for implementing automatic maintenance, being the important source in achieving automatic maintenance and the advancement of car maintenance workshops, and this development is in parallel with the application of automatic maintenance that It seeks to achieve the expected results with the least effort and the least possible time, as this application results in an increase in productivity and an improvement in the quality of maintenance, which is something that works for all organizations and industrial and service institutions alike (Abdulrahman Tawfiq 2003, p.8)

When looking at many of the maintenance services provided in car maintenance workshops, they are still below the level required to achieve the high efficiency and effectiveness required, and accordingly, the design of the Mica Troni system for automated maintenance and its application in car maintenance centers in general and in Nissan and Hyundai companies in particular, will It rises to meet the needs and requirements of the beneficiaries of car maintenance in the shortest possible time, at the lowest cost, and with high quality, so linking automated maintenance to the work system in industrial enterprises in general and in auto maintenance centers in particular, must receive scientific attention, given the expected positive return from that. In terms of promoting and raising the efficiency of service work related to car maintenance.

2. Research problem:

There are many methods within industrial establishments and auto maintenance centers. These methods depend on traditional “mechanical” maintenance, that is to say, totally and partially depending on the human element within those institutions.

This is a matter that negatively affects the productivity of the workers within the establishment, which results in an increase in the cost of maintenance and its inaccuracy with the increase in maintenance time, in addition to the absence of A study unit on "automated maintenance" in the car maintenance course to educate students of technical education on Modern methods of car maintenance The research problem is summarized in the attempt to identify the impact that will be achieved by the application of automated maintenance within the technical education curricula and maintenance centers in the Nissan Sunny 2017 and Hyundai Elantra 2015/2016 companies.

3. Research questions :

The researcher poses some questions and tries to answer them through research procedures, literature and field coexistence, and the most important of these questions are:

1- What is the effect of applying automatic maintenance by examining the reality of performance and knowing the methods currently used, and working on treating them and standing on the application of “automotive maintenance” in light of the research problem?

2- What is automated car maintenance, and the equipment for its application?

3- How can the work risks arising from traditional maintenance be reduced?

4- How can the productivity of industrial processes be improved, by means of automated maintenance?

5- What is the perception of the proposed unit?

4. Research Aims :

1- The general objective of the research is to measure the effectiveness of the automated maintenance application of cars in the car maintenance companies represented in the "Nissan Sunny car centers and Hyundai Elantra Model centers" 2015/2016/2017.

2- The special objectives of the research are to create an improved model that can be applied in the car maintenance department in light of automatic maintenance, and this is exemplified in the maintenance process at Nissan Sunny centers.

3- Improving the performance of the institution’s employees by providing a safe, risk-free work environment.

4- Presenting a list of car engine maintenance skills to train the industrial diploma students on it.

5- Utilizing the results of the research in developing the "Car Maintenance" course to raise the skills performance of art education students.

5. Research Importance:

The importance of the research is summarized in the following:

1- Through research and investigation in the field of research and studies related to the field of car maintenance in light of the concepts of automated maintenance, we have shown the lack of abundance of studies that have dealt with this aspect. Therefore, it is hoped that this study will be a scientific addition in this field.

2- Determining the methods and methods used in the maintenance of cars helps a lot in predicting and diagnosing the reality, which leads to the possibility of developing solutions to develop the effectiveness of performance in the maintenance of cars in light of automated maintenance.

3- This study paves the way - God willing - to conduct traceable studies that take specialized dimensions and deal with other variables to identify advanced methods of performance, according to the concepts of the application of automatic maintenance. Therefore, this study focuses on the impact of the application of automatic maintenance.

In the maintenance of cars represented in reaching a new, developed and improved model for maintenance operations according to the application of automatic maintenance, including the systems and continuous improvement it contains in the management of car maintenance in order to ensure survival in the competition market, which has become the customer's satisfaction of the priority of competition, and therefore it is necessary for industrial institutions to follow maintenance Mechanism for cars.

4- The research is also concerned with improving the productivity of industrial processes.

5- Designing a study unit that would raise awareness and culture towards the application of automated maintenance.

6. Research limits :

Spatial boundaries: Nissan Sunny maintenance center "Ahmed Mari Alexandria branch" - Hyundai Elantra maintenance center in Zagazig - College of Technology in Zagazig specializing in vehicles - Martyr Pilot Ahmed Fouad Bakr Mechanical School in Zagazig, three-year system for boys - Zagazig advanced technical school, five-year system for boys.

Human borders: third-grade students of specialization (cars, tractors).

Time limits: Automated maintenance was applied throughout the first semester of 2019/2020.

Objective limits: rules for automated maintenance.

7. Research Methodology:

- This research will follow the descriptive and experimental method, whereby the descriptive method is used for the study and access to the studies that dealt with the topics and themes of the research and the experimental method to measure the extent of students 'acquisition of the concepts, information and scientific skills acquired through the application.

8. Research steps :

First: Accessing previous research and studies and scientific literature related to the topic of research to prepare the theoretical framework, which is represented in the following axes:

1- Automated maintenance of cars (importance - uses - types - advantages - disadvantages - locations - limits).

2- Developing a car maintenance course for students of industrial technical education, the three-year system.

3- Conducting research and drawing conclusions.

4- Recommendations and suggested research.

Second: The Application Framework:

1- Design the maintenance robot.

2- An opinion poll on the validity of the design of robots, the application of automated maintenance for cars and their production capabilities.

3- Test the application of automated maintenance for cars.

4- Draw conclusions.

5- Development of the "Maintenance and Repair" course for students of industrial technical education, the three-year system.

9. Research tools :

1- Vehicle breakdown detection device.

2- A cognitive test.

3- An opinion poll on the validity of the design of robots, the application of automated maintenance for cars, and their production capabilities.

4- A note card for evaluating the skill performance.

5- Using the matlab statistical program to analyze the data.

6- Using the (Arduino) program to enter codes and implement a simulation of them.

7- Using (python_script) to read the sensor codes.

10. Research terms :

Maintenance:

Maintenance involves keeping production tools in proper operating condition using a combination of repair and repair operations (Lavina: Paris, 1994, p. 14).

Maintenance is that function that works to ensure the safety of production equipment and supplies to provide the required product at the right costs and in the conditions

that the production process is going through (quality, quantity and occupational safety) (Shawqi Naji Jawad: Amman, 2000, p. 479).

The modern concept of maintenance links maintenance activities with the economic life cycle, and considers it "a combination of administrative, engineering and technical work related to preserving the physical assets available to the industrial establishment, tracking its economic life cycle, and taking care of its specifications and design to ensure that it can be relied upon (Khaled Abdul Rahim Al-Hiti and others: Amman, 1997) , P. 152).

Trotechnology:

It is defined as:

"A combination of administrative, financial and engineering applications that apply to physical assets and track their economic life cycle, and are concerned with the specifications and design of the plant, equipment and buildings to ensure that they can be relied upon and carry out the necessary maintenance for them, as well as interest in installing and installing them, ensuring the validity of their use, making modifications to them and replacing them by relying on the data that It is obtained through feedback about its design, achievement and costs "(Rami Hekmat Fouad Al-Hadithi et al : Amman, 2004, p. 16)

Skill:

(Muhammad Ahmad al-Muqaddam, 1997, p. 17) defines it as a series of movements and performances that the learner performs with accuracy and speed that can be observed and measured.

Whereas (Ahmed Hussein, Ali Al-Jamal, 1996, p. 187) defines it as the easy and accurate performance of a particular activity with saving time and effort.

Maintenance of educational devices

He defines it (Ali Muhammad Abdel Moneim 2002, p. 13) as a process aimed at preserving the devices and keeping them in good condition permanently, making them suitable for use to do the work that should be done effectively and efficiently.

(Muhammad Jaber Khalaf Allah Ahmad 2003, p. 14) defines it as the process by which we protect and maintain educational devices and make them permanently usable and carry out simple repairs and replace spare parts if necessary to ensure that the equipment does not stop and performs its role effectively.

Instructional design

He knows it (Abd al-Latif al-Jazzar 1995, p. 253) as: It is a general plan for a process that consists of several successive, interacting sub-processes that depend on each other and are carried out in equilibrium and self-organization to achieve a specific goal or a set of specific goals.

Mechatronics

It is a word that combines and describes the integration between mechanics, electronics and computer technology in the complex design processes of products, and this integration is an effective integration for the increase and is also considered a philosophy in the design process and this philosophy represents the optimal use of available technology and the interference of mechatronics engineering uses in many applications, including systems Modern control and control of airplanes and cars (University of Waterloo, Ontario, Canada Mechatronics Engineering).

Arduino:

Arduino or Arduino is a small computer that can interact and control its surroundings better than a desktop computer. Technically, it is an open source software platform consisting of a Micro-Controller and an IDE (https://arduino-ide.en.softonic.com).

Engine fuel system:

The function of this system is to deliver the fuel from the tank to the engine after filtering it from impurities and dirt, then mix it with air and distribute it to the cylinders at certain rates according to the speed of the car

(Stockle, Martin T; Park, Illinois, 2000).

"Feeding" carburetors

It is the atomization of liquid benzene (converting it into a dispersed atomizing spray) that is suspended in the air passing around it to turn into steam at high speed. Thus, the nutrient acts as a gasoline evaporator and transforms it from a liquid state to a semi-gaseous state so that the thermal energy inherent in it can be obtained.

(Book of internal combustion engines - Ain Shams University - College of Engineering - Department of Cars).

Engagement:

It is the development of the carburetor and it is better in terms of performance and saving gasoline, the way it works is very easy, we all know of course that the motor burns a mixture of air and gasoline. Then calculating the air to fuel ratio, and on the basis of which the control gives a command to the sprinklers to spray a certain percentage of gasoline on each mist (William Krause, Auto Mechanics).

Worker Capacity:

Ability is the rate at which a worker is exerted work or a person's power to do and master something.

Work study:

It is a comprehensive study that covers all techniques of productivity of production processes, including administrative work and the method used in business organization.

Unit outputs:

It is the product of the interaction between the inputs and the implementation mechanisms (curriculum) (Adamson, Lena; et al. 2010).

1. The first axis / theoretical foundations:

About maintenance:

Maintenance means all activities by which equipment and devices can be preserved in order to be in working condition (Hassan Abdullah Al-Tamimi: Amman, 1997, p. 131).

Terotechnology system in general maintenance :

A mixture of administrative, financial and engineering applications that apply to physical assets and track their economic life cycle, and are concerned with the specifications and design of the plant, equipment and buildings to ensure that they can be relied upon and carry out the necessary maintenance for them, as well as interest in installing and installing them and ensuring the validity of their use and making modifications to them and replacing them depending on the data obtained It should feedback on its design, deliverables and costs.

This is a modern concept that is consistent with the systems approach, which views maintenance as an integrated system that works in coordination with various other systems in the organization, to reduce the time and cost of faults and maintain the quality of products.

The term Trotechnology can be clarified through Figure (1) (Rami Hikmat Fouad et al .: 2004, p. 17):

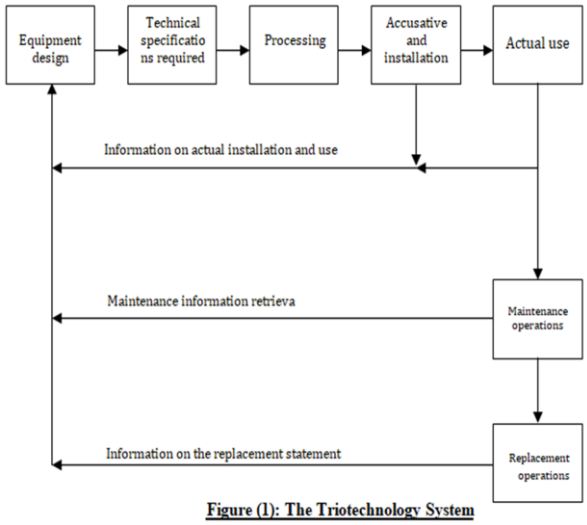


Figure (1): The Triotechnology System

It is evident from the above figure that maintenance operations are not limited to the traditional maintenance activities represented in periodic detection and repair of faults, but rather begins with the beginning of developing designs for production facilities and developing technical specifications appropriate to operating conditions, and continuing to improve these processes through feedback on the performance of maintenance, replacement and detail work Or any other observations that contribute to the development and treatment of the deviations in a timely manner.

Through the foregoing, it can be said that the maintenance function is "all the engineering, technical, administrative and financial activities that ensure the continuation of the production process without unplanned interruptions, and contribute to maximizing the value of the organization by providing products and goods that satisfy the needs of its potential customers at an appropriate cost and at the required time."

Optimization criteria for maintenance processes and costs:

Every work needs a standard or an indicator to judge the extent of its success or failure in achieving the purpose for which it was established, and the body that set the standard may be affected by historical data so that its standard is historical, and some mathematical and statistical methods may be used with the aim of moving towards science, and in any case the criterion must be described Realism, flexibility and clarity, and most of the levels that will apply it must take part in preparing it, in order to obtain the confidence of these parties and thus ensure its implementation.

In order to know the efficiency and effectiveness of maintenance management, a set of ratios and indicators are used that are extracted from the financial statements and document systems of the maintenance department.

1.1 Indicators of maintenance cost analysis:

Maintenance department officials use a set of indicators to study and analyze the budget allocated for maintenance, and this is in order to take the necessary measures and necessary actions that enable them to determine the appropriate business strategy to achieve actual cost-effectiveness, and to embody the established goals, and they can also:

(F. Monchy, DUNOD, Paris, 2003, P 367).

- Review the applicable maintenance policies and make necessary adjustments.

- Estimating the size and type of business and activities according to the available capabilities;

- A good estimate of the appropriate size to balance the future period.

Table No. (1): Indicators for analyzing maintenance costs

Indicators (percentages)	The importance of use
Cost of preventive maintenance / Total maintenance cost	It shows the level of preventive maintenance, and it is related to indicators of maintenance effectiveness and failure rate.
The cost of remedial maintenance / Total maintenance cost	It shows the importance of remedial maintenance, its level of use, and its costs relative to the total maintenance cost.
Cost of critical operations (major operations) / Total maintenance cost	It is useful in making the decision to replace the equipment.
Contracting cost (implicit contracting) / Total maintenance cost	Determine the branch and level of self-actions and interventions, as well as the level of need for foreign aid
The cost of materials and spare parts / Total maintenance cost	This indicator is useful in knowing the extent of control over the available capabilities, and also helps in determining the amount of excessive use of spare parts
Direct maintenance cost / The added value of the product	It is useful for measuring the efficiency of the maintenance activity and the qualitative addition it achieves
Maintenance cost accumulated for a specific production division / (Number of working hours)during a period of time	It is useful in finding the relationship between the accumulated costs of maintenance, distributed over the working hours of the production unit concerned.
Total realized renewal costs / Equipment yield	It is useful to determine the percentage of extending the useful life of the equipment.
Cost of maintenance / Breakdown cost	An indicator that reflects the quality of maintenance activities and operations.
Total maintenance cost / Total production cost	An indicator used to determine the ratio of maintenance cost to total production costs, in order to estimate the work and predict the size of the budget for the upcoming period.

Table No. (1): Indicators for analyzing maintenance costs (Shawqi Naji Jawad 2000, pg. 489)

1.2 Indicators of maintenance cost analysis:

The best way to manage maintenance work is through the maintenance department obtaining an abundant amount of information to help it know its performance levels, and the maintenance department can rely on a set of indicators and criteria that enable it to judge the level and quality of applied maintenance, and these indicators are:

A- Reliability Index: Fiabilité (Reliability)

Reliability is the probability that a device will continue to function well for a certain period of operation under specific conditions of use (J. Gerbier: LAVOISIER Paris1993 p495).

The reliability index is characterized by a set of characteristics that can be mentioned in the following:

The concept of reliability applies to:

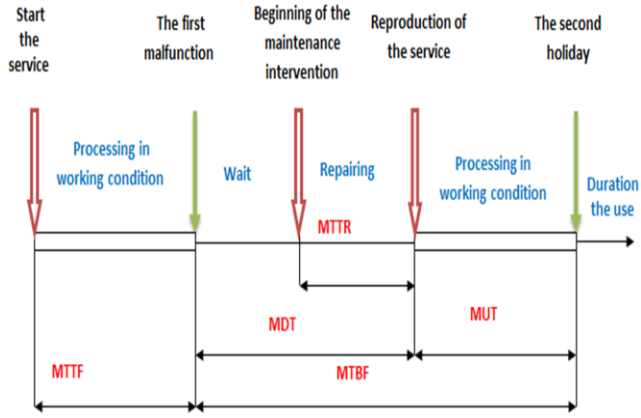
- Equipment and devices that can be repaired (industrial supplies).
- Systems that are not repairable (parts, lamps, ...).

The equipment has good reliability if the number of faults is minimal.

Reliability can be measured by calculating MTBF or Mean Time Between Fault (G. Bosser et J.M. Guillard 1990 p170).

The various periods of repairable systems can be illustrated in the following figure:

Figure (2): The successive cases that repairable systems go through



F.Monchy : Maintenance-méthodes et organisations-,2 ème édition, DUNOD Paris, 2003, P 371.

MTTF: The average time before the first malfunction.

MTBF: It is the average uptime.

MDT: The average downtime.

MUT: It is the average uptime available for operation after a crash repair.

MTTR:The average technical time spent repairing.

1.3 Maintenance failure rate:

It is known as the inverse of the average time trapped between faults, and it is denoted by the symbol (λ) and is usually measured in hours of operation, and it is very necessary especially in companies that use new production lines that cause confusion to the human element, and it is given by the following relationship: $\lambda = 1/MTBF$

The failure rate gives the possibility of failure of the facilities that have been in operation for a certain time at any next time. The failure rate is an important indicator for the reliability analysis.

B- Maintainability Index: Maintenanceabilité (Maintenance)

It is the process of using maintenance works, methods, and resources on the device in order to reuse or maintain it to perform the required task under certain operating conditions (Javille: et al. DUNO, 2003, p259).

The maintainability indicator is characterized by a set of characteristics that can be mentioned in the following:

- The maintainability indicator indicates the ability to restart the device after performing the repair process.
- Maintainability is associated with repairable systems only.

Maintainability can be improved by (J.C. Francastel: 2003, P 466):

- Improve procedures for maintenance interventions.
- Provide necessary spare parts;
- training of maintenance personnel;
- The ability to determine the causes of the outages and the ability to design methods to sustain or increase the time between faults.

Maintainability can be measured by calculating the average technical repair time, given by the following relationship:

$$MTTR = \frac{\text{Total times of maintenance interventions}}{\text{The number of faults}}$$

C- Availability Index: Disponibilité (Availability):

It is the efficiency of the device - under interrelated factors of reliability and maintainability - in achieving the required function within the specified conditions of use and during a certain period of time (F. Monchy: 1996, P 181)

The device would have good accessibility if (G. Bosser et J.M. Guillard: 1990 P 172)

- The stop rate is the lowest.

The ability to restore the device's operational status in the shortest possible time.

Equipment availability can be improved by:

- Increase the degree of reliability of the device (increase MTBF).
- Minimizing repair times (MTTR reduction).

The availability index is given by the following relationship:

$$\mathcal{D} = \frac{\text{MTBF}}{\text{MTBF} + \text{MTTR}}$$

1.4 Types of maintenance :

A- Preventive Maintenance:

It is a set of checks and services that are carried out periodically and according to a set time plan (determined by the machine manufacturers or by experienced technicians in charge of maintenance) to address the deficiency, if any, before the occurrence of a breakdown or stopping work.

The preventive maintenance operations are carried out daily, weekly and monthly, as the apparent periodic inspection of the parts and units of the machine and the cleaning, lubrication and oiling operations and changing some simple parts if necessary.

B- Corrective Maintenance:

It is the set of operations that are carried out to repair the machines according to a set time plan (determined by the machine manufacturers or by experienced technicians in charge of maintenance) and in which:

Damaged parts change or out of date parts.

C - Emergency or emergency maintenance:

It is the set of operations that are carried out to repair machines as a result of a sudden damage that leads to the unplanned parking of the machine. Usually the cause of this malfunction is the failure to follow the manufacturer's instructions (wrong operation) or the failure to apply correct preventive maintenance.

Cost and budget are one of the most important tools in the maintenance department:

The cost or budget is to be able to keep track of the expenditures for each task and to ensure that the department works within the allocated budget. In addition, it is necessary to give the specialized workforce the authority to follow up.

These units are what contribute to building the maintenance function, it is not necessary to complete all these units at the same time and the following model suggests Figure (3) to accomplish these units:

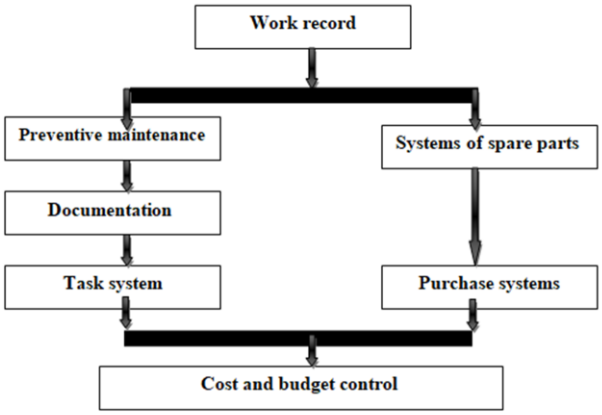


Figure (3): A model for accomplishing maintenance systems measurement units (Sami Mazhar Qantaji 2003, P21)

Maintenance Policies:

Maintenance is an expensive business, as it includes an element of indirect costs, so the administration must take care of it and work to reduce it, and despite the constant improvement in methods and methods of maintenance to facilitate the development of a successful policy for it, until its costs rise from year to year due to the continuous rise The wages of workers on the one hand and the increasing number of machines and equipment required to be maintained on the other hand.

The maintenance policy is defined as defining the technical, economic, and technical objectives at the enterprise level and related to the maintenance work of the equipment.

(priel, V. la maintenance technique moderne de gestion France, 1997, P 41).

The maintenance policy can be shown in Figure (4) as follows:

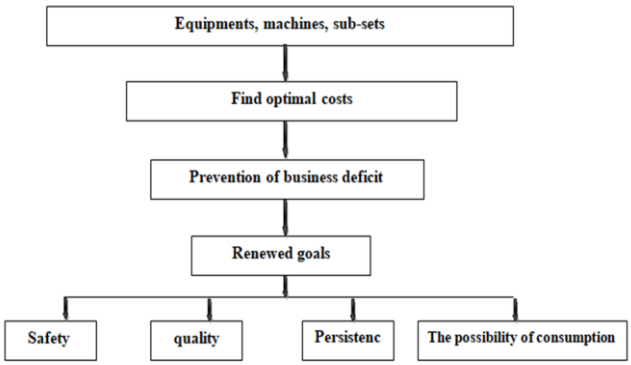


Figure (4): Presenting the maintenance policy

Steps to prepare maintenance planning (Aref Muhammad Suleiman 2006):

- Prepare plans and programs for planned maintenance and repairs for each equipment separately.

- Preparing plans and programs for maintenance and major equipment repairs.

- Develop plans for the needs of spare parts, oils and lubricants.

- Developing detailed maintenance plans and programs and coordinating between them and the operating programs.

- Develop plans for loading the various workshops in light of the available capabilities.

-Determine the material and material capabilities required for maintenance management (devices, equipment, labor ... etc.).

- Carrying out the necessary studies to make a trade-off between buying a new equipment or rebuilding the current one.

- Participate in identifying and selecting the type of equipment to be purchased.

Other activities.

1.5 Administrative organization for maintenance:

The organizational structure of maintenance management depends largely on many factors, including the size and type of the industrial establishment and its management style.

There are many types of organizational structures that are used in maintenance management, which are (central organization, decentralized organization, matrix organization) (Rami Hekmat and others 2004, p 210) .

1.6 Maintenance costs :

There are fixed, variable, semi-fixed and semi-variable maintenance costs:

Fixed maintenance costs result from the retirement burdens conducted by the institution, and related to maintenance management such as rent, insurance, salaries and wages that are fixed in time contracts, and depreciation of maintenance units due to technical progress. As for the variable maintenance costs, they accompany the operations, and usually change in fixed, progressive or descending rates with change The volume of production and the maintenance cost is semi-variable when there is a production stoppage. Fixed and variable maintenance costs, semi-fixed and semi-variable maintenance costs can be represented by curves Figure (5) as follows:

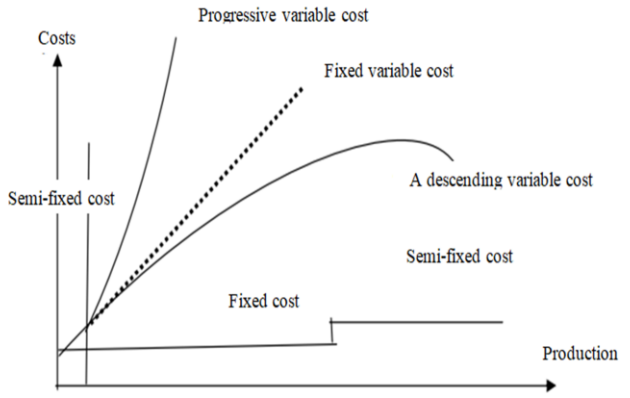


Figure (5) fixed, variable, semi-fixed and semi-variable cost curves (Sami Mazhar Qantaji 2003, p.61)

1.7 About programming:

Programming is the process of writing instructions and directing commands to a computer or any other device such as DVD readers or audio and video receivers in modern communication systems, to direct this device and inform it of how to deal with data or how to carry out a series of required actions called an algorithm. (Proc. 1971 IF1P Conference, Ljubljana, Yugoslavia, 1971, pp. 250-255).

The programming process follows the rules of the language chosen by the programmer. Each programming language has its own characteristics that distinguish it from the others and make it suitable to varying degrees for each type of program and according to the task required of this program. The programming languages also have common characteristics and common limits, by virtue of the fact that all of these languages are designed to deal with the computer. Programming languages develop with the development of the visual computer hardware (hardware). When the computer was invented in the forties and fifties (after electrical computing devices in the twenties) and the computer was running with large numbers of electronic valves - the programming language was complicated as well. Even it was a series of numbers only zero 0 and one entered, because the computer understands only two cases of current (1) or no current (0), and this was difficult for programmers, but by inventing the transistor, the size of the computer was greatly reduced and its capabilities increased. Professionals at the same time created languages that were easier to use, and programming languages became widely understood by professionals. Development and facilitation is still ongoing and these languages are called easy-to-work for programmers in high-level languages (Competeers, C 1976, p 12-25).

Computer programming:

It is the process of writing, testing, correcting errors and developing the source code for a computer program that a human can do. Programming aims to create programs that implement and implement algorithms that have a specific behavior in the sense that they have a predetermined function and expected results, this process is done using one of the programming languages, the goal of programming is Creating a program that performs specific operations or exhibits a specific required behavior. In general, programming is a process that requires knowledge in various fields, including knowledge of mathematics, logic, and algorithms (Warren, Michigan, 1974).

2. The second axis / related studies:

2.1 Al-Jubouri's study: (Maysar Ibrahim Ahmed 2010) :

The study aimed to assess, simplify and improve the impact of applying Total Quality Management (TQM) on maintenance operations in American, Japanese and Korean auto maintenance centers in Riyadh, Kingdom of Saudi Arabia. The study was conducted by identifying the personal opinions (online) of the employees regarding the steps taken for the maintenance process, and it resulted in the development of new and improved quality control and control models that reduce time and cost compared to what has been practiced in auto companies.

2.2 The study of Hashem Muhammad Salem (2015):

This study consists in creating an improved model that can be applied in the management of car maintenance in light of the total quality management, by getting acquainted with the opinions of administrators, technicians and personal workers in the car maintenance department, and this is represented in the maintenance process in auto maintenance centers.

2.3 The study of Jarosław Szrek, Jacek Wodecki, Ryszard Błazej and Radoslaw Zimroz (2020):

Mechanical systems are known to require supervision and maintenance procedures. There are a lot of condition monitoring techniques in common use, and in the era of IoT and predictive maintenance, one may find plenty of solutions for various applications. Unfortunately, in the case of underground mining conveyor belts, the list of possible solutions is rapidly diminishing.

The reason is that they are specific mechanical systems - a typical conveyor is located in a mining tunnel and may range from 100 to 1,000 meters in length. According to the mining regulations, a visual inspection of the conveyor road should be made before starting operation. On the other hand

On the other hand, given that the environmental conditions in the mining tunnels are extremely harsh and the risk of accidents is high, there is a tendency to reduce the human presence in the tunnels. In this paper, we propose a prototype of an inspection robot based on a UGV platform that can support maintenance personnel during examination. At present, the robot is controlled by an operator using the radio, however, we are planning to make it autonomous. Moreover, it could be his support, Large - where the robot can "see" elements of the carrier path (RGB camera) and hotspots can be identified using infrared thermal imaging. Moreover, the locations of the detected hotspots can be located and their position can be stored with both types of images. In parallel, it is possible to preview images in real time and stored data allowing analysis of the condition of the transmission system after an inspection mission. It is also important that due to the wireless control systems the operator can stay in a safe place. This robot can be classified as a mobile monitoring system for spatially distributed underground infrastructure.

2.4 The study of Wael Ahmed Khalifa's (2019) :

This study explored and analyzed issues related to robotic weapons and how to use different types of robot control systems, both traditional and modern technologies. Power mode for all communications, then this model was developed so that it is easy to monitor and study each variable separately and also facilitate the application and simulation of the various control system operations on a personal computer.

2.5 The study of Rami Hikmat Fouad (2004) :

The study aimed that the strategy in planning and implementing preventive and curative maintenance work is based mainly on giving priority to preventive maintenance, given that the companies' equipment is relatively modern, as the cost of preventive maintenance represents the largest part of the total maintenance costs, and this is due to the excessive consumption of spare parts in particular. , Which led to an inflated preventive maintenance cost, while remedial maintenance costs represent only a small percentage of the total maintenance cost, and the latter remains a percentage of its representation from the total production cost within the reasonable range, which gives the company the opportunity to double maintenance work while saving on consumption. Replacement parts and parts, I worked out The study aims to reduce the size of the stops and increase the readiness of equipment, which gives companies the opportunity to double the operating periods, which allow the regular flow of the company's products according to the required specifications, with a quality that meets the aspirations of customers and meets the ISO9000 standard specifications, in light of the increasing challenges faced by companies calling for the need to work from For continuous development to reach high levels of efficiency and effectiveness.

2.6 Study Xiaofeng Cai, Huansheng Ning, Sahraoui Dhelim, Rongjuan Zhou, Tao Zhang, Yang Xu, Yueliang Wan (2020):

Robots, as man-made, are an indispensable component of human society. With the improvement of technologies, robots are getting smarter and they are widely applied in many fields, such as disease diagnosis, customer services, car maintenance, healthcare for the elderly, etc. As robots have made our lives more comfortable than ever, they have also brought many potential risks and challenges in technology, security, and ethics. To better understand the evolution of robots, we proposed a concept of robot living space and analyzed the role of robots in our society. In this paper, we focus on developing a theoretical framework for a robot's living space to understand the relationship between humans and robots more, the research in this paper contains three central works. First, we explain the concept of the robot's living space and the functions of each space. Second, we analyze and summarize the relative technologies that support the lives of robots well everywhere. Finally, we provide advice and improvement actions based on a discussion of potential problems caused by robotics developments.

2.7 The Study Balakrishnan Ramalingam Jia Yin, Mohan Rajesh Elara, Yokhesh Krishnasamy Tamilselvam, Madan Mohan Rayguru, M. A. Viraj J. Muthugala and Braulio Félix Gómez (2020):

The role of mobile robots for cleaning and sanitation purposes is increasing around the world, disinfection and hygiene are an integral part of any safe indoor environment, and these factors become more important in epidemic situations. Similar to COVID-19, so door handles are very sensitive to contact points exposed to contamination, and the study has found a robot design for the process of cleaning door handles because this is very important to ensure safety, also to improve efficiency.

This work proposes an AI-enabled framework to automate cleaning tasks through a Human Support Robot (HSR). The overall cleaning process includes mobile base movement,

door handle detection, and HSR manipulator control to complete cleaning tasks.

2.8 The Study: Instituto Superior Técnico, Lisbon, Portugal, September (2015):

Maintenance and management of maintenance services is presently being presented as an important factor regarding the competitiveness of companies operating in the automotive industry and the market. This level of importance is due to the fact that actions taken at this level have direct impacts on costs, deadlines and on the quality of products and services provided. In this way, running these areas simultaneously is key to ensuring availability and responsiveness in relation to the requirements in the automotive aftermarket. In terms of inventory management, this thesis aims to contribute to improving the availability of maintenance components in inventory. In order to ensure a competitive service level for the market. This increases the need to ensure the best compromise between inventory costs, availability of components in storage and operability of mechanical maintenance workshops.

This case study provides a methodology for classifying a component keeping in mind their demand patterns. It provides methods for identifying and classifying these demand patterns and determining an appropriate forecasting method. A dynamic model has also been developed that allows to respond to multiple verified demand needs, automatically adapting to each type of demand. The model automatically adjusts stock replacement parameters, adapting to various operating scenarios regarding inventory management.

2.9 The Study: Juha Rusama Degree Programme in Service Innovation and Design (2012) :

The study aimed to develop a new concept of car maintenance service and a service path for business customers in Fehu Automobile Oei Petajanmaki Company, both the concept of maintenance service and service path were developed using the experimental data collected from business clients in Fehu Automobile Oi Betaganmaki. Service concepts. The issues addressed in the theoretical framework are service path, service concepts, service scheme, goods, and dominant service logic. Empirical data were collected using a sentence completion form. Respondents were chosen from among the decision-makers of the corporate clientele of Fehu Automobile Oei Petajanmaki. The invitation to respond to the sentence completion form was sent by e-mail to 38 decision-makers, of whom 17 returned the completed sentence completion form. The response rate was 45%, and it can be considered relatively high.

2.10 The Study: Division of Logistics and Transportation CHALMERS UNIVERSITY OF TECHNOLOGY Gothenburg, Sweden, (2011) :

Machine-dependent company like SKF every minute of unplanned machine downtime is so costly, so quickly correcting machine malfunctions is critical and for realizing that corrective maintenance is a vital process. With the aim of improving corrective maintenance in SKF Gothenburg, this thesis was implemented as a case study in the company, to be able to evaluate corrective maintenance operations. A model was created, and then this model was used with data collection, observations and interviews to evaluate how maintenance was carried out at SKF Gothenburg. Based on the results of these, three areas of improvement were found; Goal setting, resource planning and communication. Also nine different recommended measures for SKF to take are presented in the three areas. If these measures are taken, corrective maintenance in SKF Gothenburg will be more efficient and the overall repair time will decrease.

Summary of previous studies:

Through a review of previous studies and research concerned with maintenance operations and the use of robots, and their impact on cognitive achievement and skills performance, the following can be concluded:

1- The main objective of most of the previous studies and researches was to identify the effectiveness of maintenance, and those studies have proven the effectiveness of maintenance in developing some dependent variables related to achievement and performance of practical skills.

2 - The scarcity of research that has been interested in developing a Mica Troni system to do automatic maintenance such as

Study (Jarosław Szrek2020).

3- The absence of Arab studies (within the limits of the researcher's knowledge) dealing with the maintenance of a programmed machine for devices and machines, and how to design them.

4- No study has been studied within the researcher's knowledge of the effectiveness of maintenance in developing automobile maintenance skills.

Therefore, the researcher tried to provide an educational system designed by Mica Troni that helps in automating the maintenance of cars in the engine fuel cycle. This system has been used to impart car maintenance skills to third-grade students in industrial secondary schools, the three-year system - specialization cars.

As none of the previous studies (within the limits of the researcher's knowledge) dealt with the use of a programmed system to impart these skills.

Benefits from previous studies in the current study:

The researcher benefited from the studies and research of the previous axes as follows:

1- Determine the theoretical framework of the current study.

2- Learn how to build and prepare study tools:

A list of skills for car maintenance skills (engine fuel cycle).

Note card.

The achievement test.

3- Formulating and directing the study hypotheses.

4- Analyzing educational maintenance operations and arriving at the system designed by Mica Troni for automatic maintenance.

5- Reaching some procedural definitions of the terms used in the current study.

6- Interpretation of the results of the current study.

The table also lists the results of the exploratory study questionnaire for students of technical secondary education, the three-year system - the automotive specialty.

Item	Response	
	Yes	No
Can you deal with auto breakdown devices?	30 %	70 %
Is there sufficient time in the department to train on maintenance skills?	25 %	75%
Do you know the components of the car engine?	40 %	60%
Have you disassembled and installed every part of the car engine?	10%	90%
Did you know the faults of every part of the car engine?	12 %	88%
Can you clean and maintain the needle valve?	15%	85%
Have you maintained and repaired these faults yourself?	8%	92%
Can you deal with the computer and download a program?	24%	76%
Can you clean and maintain the engine fuel cycle?	20%	80%
Can you identify the parts of the engine fuel cycle?	35%	65%

Table No. (2): The results of the exploratory study questionnaire (the researcher)

In light of the results of the questionnaire, the researcher found that there is an essential need for students to acquire the skills of car maintenance in general and maintenance of the engine fuel cycle in particular, as it is one of the most important educational devices used in educational institutions.

3. The third axis / the experimental (practical) aspect:

The researcher used the quasi-experimental approach to reveal the effectiveness of the system designed for maintenance as an independent variable in increasing the achievement and imparting the skills of maintenance of the car engine (the engine fuel cycle). This may require the use of the experimental design known as the pre-design, the post design using two equivalent groups, one control and the other experimental.

This design uses two equivalent groups, one of them is a control and the other is experimental, where the research tools are applied before the two groups before the experiment, then the experimental group is exposed only to the independent variable of the designed system (mica troni to implement the automatic maintenance) while the control group studies the traditional method of maintenance and then applies the research tools to the two groups.

3.1 Robots in the automotive industry:

But given that machines are better suited for brutal or toxic tasks, we may choose to mention the wonderful opportunity for job growth that the robotics industry itself offers, and thus, the evolving role of humans in the automotive industry in general, as Figure (6) illustrates the evolution of robots in industry around the world .

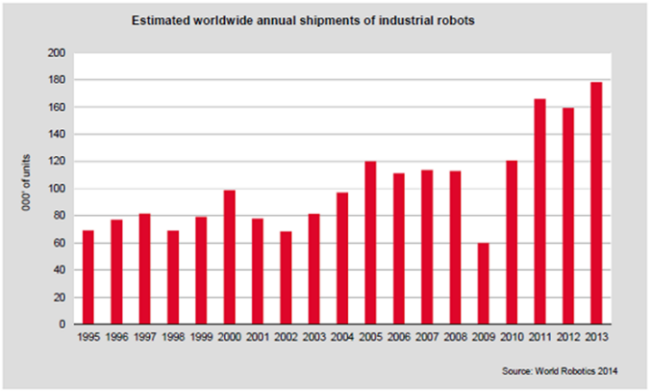


Figure (6) the evolution of robots in industry around the world

You can see a very clear trend in the chart above; As of 2013, when sales jumped 12% and surpassed, the global population of working industrial robots was around 1.6 million. Analysts expect that to reach 2 million people by 2020. For every 10,000 employees in the automotive industry, there are more than 1,500 robots.

So, if on the manufacturing side all the mechanics tell that learning how to service the tools that make cars becomes more important than learning how to build the car itself.

In the short term, it may be better to plan for more complex diagnostic tools,From here, the researcher used a group of electrical, electronic, and mechanical components to build the designed system (the robot responsible for carrying out the automated maintenance process).

The steps for implementing the automated maintenance process were based on the following diagram (Figure 7):

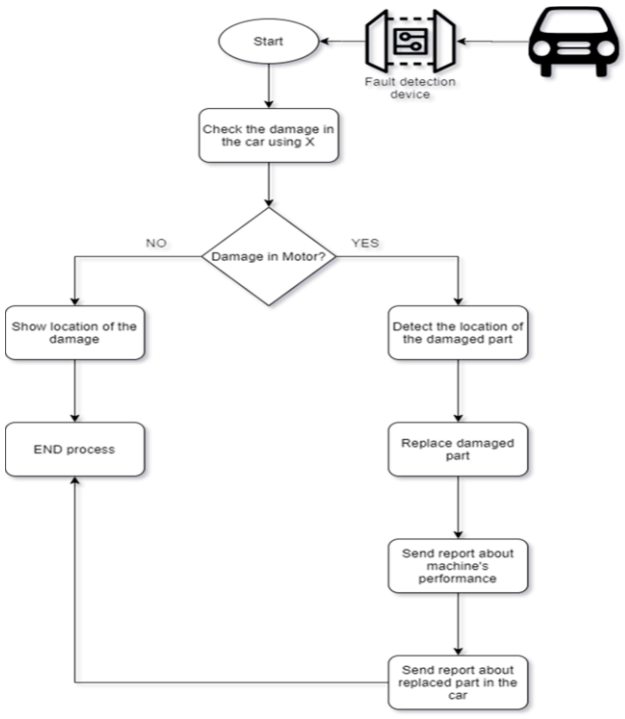


Figure (7) a flowchart of the project in implementing engine maintenance

3.2 Defining general objectives for the content of practical experiences :

Setting goals is an essential step on which the rest of the steps are based. To be the basis for determining the content of practical experiences and educational strategy. Appropriate educational media and assessment tools. This research seeks to identify the best design for the Mica Troni system to carry out car maintenance and the optimal use of tools and devices used in the experiment for students of technical secondary education in the automotive department "in light of integrated learning. This helps in achieving the learning results that students should reach after studying the experiment proposal Operation, not limited to Not only cognitive goals, but also technical and emotional goals. The researcher defined the general objectives of the proposed practical experiences in light of the findings of the researcher in the engineering section of this study.

It is limited to special technological innovations, laboratory robotic devices and systems in maintenance operations, especially in car maintenance, as well as theoretical foundations for improving maintenance operations.

3.4 Determining procedural objectives for the content of practical experiences:

Building on the previous definition of general objectives for the content of practical experiments, the behavioral objectives of each trial were formulated in a procedural form that can be observed and measured to determine the mean in which they were achieved. These goals are phrased in terms that describe the expected behavior of students after they study each trial.

These objectives describe the behavior or performance that the learner should perform after the completion of practical experiences, through the accurate description and definition of this behavior, so that both the learner and the teacher can distinguish it.

3.4.1 Classification stage :

The researcher reviewed the educational goals mentioned above and then classified them in light of the list of general and procedural goals and the list of educational skills and tasks, in preparation for designing and preparing an integration strategy, as well as defining the role of the teacher and the learner during traditional education in classrooms, workshops and laboratories and their role in e-learning.

3.5 The general plan for implementing practical experiments The researcher carried out the procedures for implementing the (theoretical / practical) part of the experiments through several meetings:

The first meeting: The theoretical part of the experience of watching robots in the implementation of installation and assembly operations for cars in one of the major factories in Europe via the Internet (https://youtu.be/uvpiKrtvRGQ ،https://youtu.be/5iOTfZl5JL0).

Hence, the maintenance experiment was carried out at the Ahmed Mari Car Agency in Alexandria, and the Hyundai agency in Zagazig, in addition to industrial workshops and secondary schools of secondary education in two specializations - cars.

3.6 The prototype of the Mica tronic system to perform automatic maintenance of the car as in Figure (8):

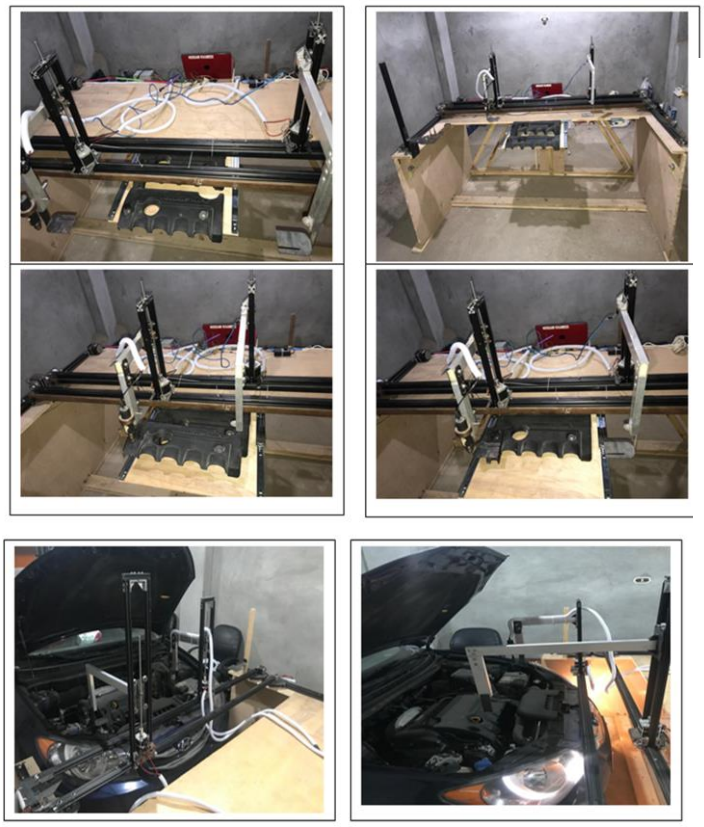


Figure (8) Determining the prototype of the mechatronic system

3.6.1 The different forms when performing the required operation:

Figure (9) shows the different directions to operate the Mica Troni system when performing the required maintenance in the fuel injection cycle. It also shows the different shapes before starting the operation when entering the car to implement the required process for the project and the different ways to enter the car before starting the maintenance process.

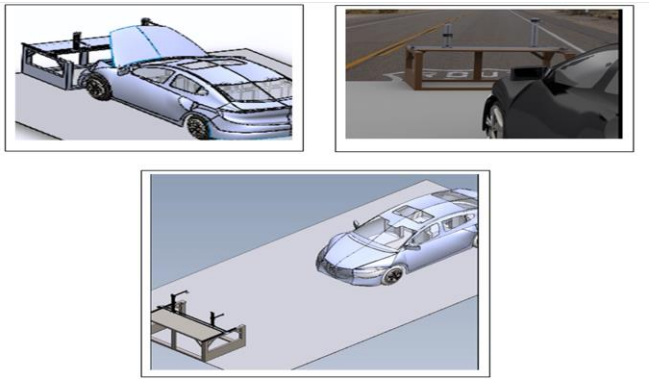


Figure (10) shows the different directions of operation of the mica troni system

3.6.2 Geometric shape and projection of the mica system are seen from three directions:

Figure (11) shows the various projections of the project with the general shape of the engineering perspective

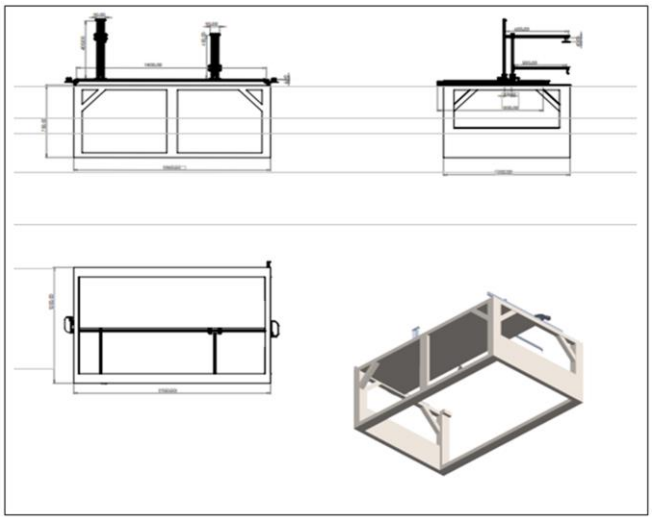


Figure (11) shows the three projections of the designed system (mica troni)

3.7 Results of maintenance parameters when performing the operation (motor speed, feed rate, depth of jaw, temperature and vibration measurement) in the maintenance process, using the system designed by Mica Troni in the maintenance process:

After measuring the vibration and temperature of the maintenance process with different operating conditions (operating speed, feeding rate and coordinate movement) the speed of each step was measured, the temperature was measured and the execution speed was measured, the vibrations were measured each time by a piezoelectric device, and the temperature was measured by the LM35 sensor. (10) values were taken for each process, then the average temperature and vibration were calculated for each sample.

37.1 The average temperatures of the parts of the mica system are Troni when performing maintenance:

Machine going to the location of the parts												
Stepper motors Temperature						DC motor	Vibrations			Time	Notes
m1	m2	m3	m4	m5	m6		m5	m6	DC		
20.16	19.88	19.94	18.62	19.56	19.45	20.21	2	3	5	35	
Unwinding second of the parts											
Stepper motors Temperature						DC motor	Vibrations			Time	Notes
m1	m2	m3	m4	m5	m6		m5	m6	DC		
20.57	19.98	20.12	18.67	19.76	19.44	21.65	3	2	11	5	
Removing second partsand install it into safe place											
Stepper motors Temperature						DC motor	Vibrations			Time	Notes
m1	m2	m3	m4	m5	m6		m5	m6	DC		
22.20	21.74	21.01	19.72	20.56	19.45	21.65	3	3	5	35	

Table (3) The speed, temperature and vibration of the device when removing parts from the beginning until returning to the point of origin again

Figure (12) shows the display of the parking space dimensions when entering to perform the maintenance process:

3.7.2 Overall temperatures Stepper motors and Dc motors:

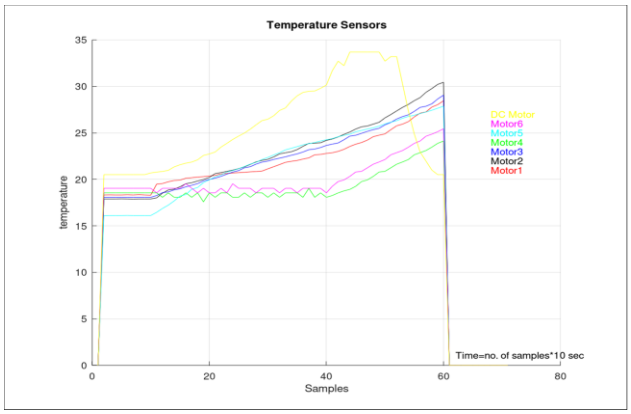


Figure (13) shows the average total temperatures of the system engines

3.7.3 Overall vibrations :

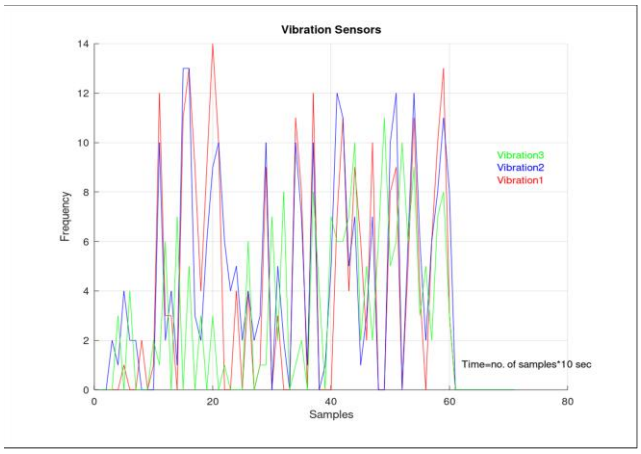


Figure (14) shows the average total vibrations of the system's motors

3.8 Results of the effect of (engine speed, temperature measurement, feed rate, vibration measurement) on the maintenance process and its effect on the mica troni

The effect of motor speed on dismantling parts for maintenance: During maintenance dismantling experiments the speed of stepper motors (step per cycle) and direct current motor (RPM) were measured. Three experiments were performed at 200, 800 and 1400 pulses per cycle, 100, 120 and 140 rpm DC motor.

The segment information is listed in [Table 3] and the average velocity is taken at 800 beats per cycle.

3.9 Results And Discussion :

Figure (13) shows the effect of motors' speed on vibration and temperature. From the figures on the engine speed, the machine's vibration increases the temperature. Table (3) shows the difference in the speed of the motors (200, 800 and 1400 pulses per cycle) in the values of the machine vibration and the temperature of the motors at the feed rate f = 120 revolutions per minute and shows the constant change in the vibration of a sample over time and it rises to a certain value i.e. Relatively constant for a given time and temperature.

Figure (14) shows the relationship between samples per second and amplitude in the time domain, the average vibration from the first experiment was determined by matlab and the arrangement was used in the experiments and the voltage was calculated (1 to 11 mV). It found a temperature (from 17.9 to 18.7 to 32.5 degrees Celsius).

Figure (13) also shows the relationship between temperature and capacitance in the time domain, as this relationship is explained by capacitance (17.9 to 32 degrees Celsius) and the frequency is (7.499, 7.505, 7.503, 7.507 and 7.505 Hz), and this indicates that the vibration is relatively small.

3.9.1 System designed mica troni

The machine consists of eight motors

- Six stepper motors responsible for the movement of the jaw tools and their connection to the places to be removed from the parts.
- DC motor responsible for unwinding.
- The servo motor is responsible for switching tools.

Control circuits

- Two arduino responsible for translating places into coordinates and sending signals to motor control circuits.
- Six stepper motors controllers
- The number of one DC motor control circuit
- Seven temperature sensors
- Three vibration sensors

3.9.2 Time taken to conduct the experiment :

•The experiment took 11 minutes to complete the jaw surgery.

•The installation process took 10 minutes to complete.

How often to conduct the experiment

- The experiment was completed five times and averaged calculations for temperature, vibration and time were taken.

3.9.3 Units for measuring motors speeds, vibration, and temperatures:

- Motors responsible for the movement of tools (pulse per revolution).

• The motor responsible for the screwdriver (revolution per minute).

• The motor responsible for switching tools (degree per minute).

• Vibrations (samples per second).

• Temperatures (celsius).

3.9.4 Average speeds of the motors during the experiment :

The average speed of the stepper motor was (800 pulse per revolution).
Average speed of the motor responsible for unwinding (100, 120, 140 RPM).

3.9.5 Observed notes on temperature and vibrations

• At the beginning of the experiment, the temperature of the motors was (17.9-18.7) degrees Celsius, and the samples of vibration were between small values (1 - 3).

• After the start of the operation process, the temperature of the motors increased and reached 32.5 less or more due to the presence of an error factor in the sensors, and we also notice the increase of the vibrations due to the movement of motors and surrounding factors.

3.9.6 Three (3) programs were used when performing maintenance, namely: -

First: the Arduino program

• The Arduino program is responsible for converting dimensions and distances into electrical signals that the device can understand and from which it can control the speed and direction of motors.

• The Arduino was used in order to automatically enter the dimensions of the parts to be disassembled and installed at the start of work without the intervention of the human factor and measuring the temperatures and rates of vibration emitted by the machine in order to insert it into the computer so that we can display a summary of the process of temperatures and rates of vibration so that we can From knowing the error rate and so on, a number (805) code has been entered in order to control the motors movement, speed and direction of rotation to enable us to dismantle and install the parts for which maintenance needs to be done and also to calculate the average temperatures and the rate of vibration emitted and output these readings to computer .

Second: The Python Program

It is a programming language that helps translate commands and steps into a language that the computer can understand, as this program was used to read the outputs of temperatures and the percentage of vibrations in the machine resulting from the Arduino readings that it sends to the computer to be stored in an excel file, to be read later at The need and he is also responsible for sending these outputs that the required operations were performed on to MATLAB to be drawn and displayed to the person following the machine. A number of orders were entered, their number (45) as in figure (19), orders to complete the tasks required when performing maintenance.

Third: Matlab program

It is a program responsible for performing complex mathematical operations and drawing the outputs of these operations easily and smoothly, through which it is possible to read an excel file and extract its data and draw it.

This program was used in the project to extract the desired data from the files coming out of Python and draw them quickly because it can read the desired files, in which the data on the temperature of the motors, the percentage of vibration, and so on are stored easily and quickly, and extract the curves as in Figure (13) And Figure (14).

Work steps:

It takes place in three steps As shown in Figure (15)

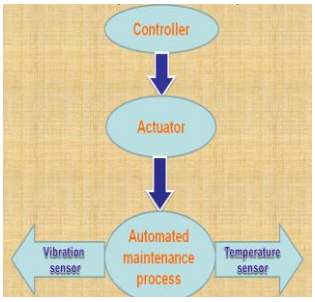


Figure (15) Steps for conducting the experiment

3.10 Robot action diagram :

Figure (16) shows the steps for implementing the practical side when performing the maintenance process, starting from entering the car to the right place, the robot takes the control command for the standby mode from the origin point, and when the car enters the end of the specified path for the maintenance process until the car is parked in the right place for it and is done Confirm this by means of the signals of the ultrasonic device.

Where the fault detection device is connected to the car in the designated place that if the device detects that the malfunction in the car exists in the engine fuel injection cycle, the robot follows the work rules, and begins to carry out the maintenance process, and during the implementation of the process, the control department sends a report on the operation to the computer on the Matlab program in order to note The movement of the robot during the implementation of the maintenance process until the end of the specified maintenance process.

In the event that the malfunction detector detects that the specified defect in the car does not exist in the fuel injection cycle in the engine, the robot does not follow the rules of work and has not moved from the point of origin and the maintenance process is not carried out because the system designed for maintenance only follows the maintenance of the fuel cycle.

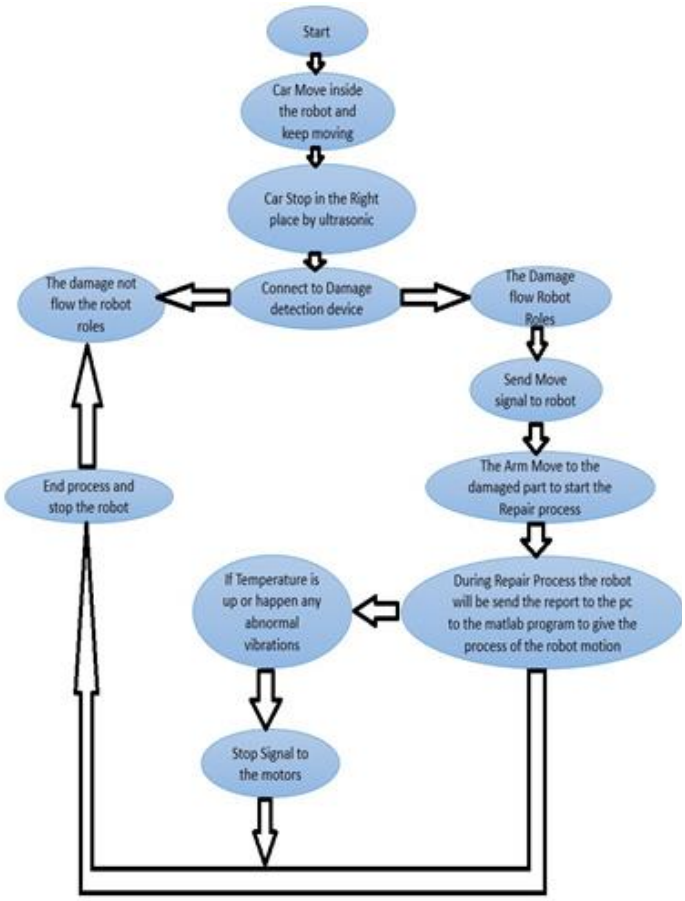


Figure (16) shows a diagram of the robot's movement when carrying out maintenance

3.11 Unwinding operation experiments to choose the optimal time to carry out the maintenance process :

- **Unwinding parts from car**

A) First Experiment

NO	Items	M1	M2	M3	M4	M5	M6	T	DC	Tem	Vib	Notes
1	Part 1	200	200	200	-	200	-	6	100	19.4	11	The fifth part, which is the stage of removing the parts from their and placing them in the place designated for them
2	Part 2	200	200	200	-	200	-	7		19.5	9	
3	Part 3	200	200	200	-	200	-	5		21.3	9	
4	Part 4	200	200	200	-	200	-	3		22.4	8	
5	Part 5	200	200	200	200	200	200	5	-	21.9	5	
SUM								26				

- This experiment has low vibrations and low temperature but it takes long time to finish the process .
- Measuring units
  - Motors from 1 to 6: Pulse per revolution
  - DC motor: RPM
  - Time: Minutes
  - Temperature: Celsius
  - Vibrations: mv

Table (4) the first experiment in the process of decoding parts to determine the optimal time for maintenance

B) Second Experiment

NO	Items	M1	M2	M3	M4	M5	M6	T	DC	Tem	Vib	Notes
1	Part 1	800	800	800	-	800	-	4	120	19.4	12	The fifth part, which is the stage of removing the parts from their and placing them in the place designated for them
2	Part 2	800	800	800	-	800	-	3		21.6	11	
3	Part 3	800	800	800	-	800	-	3.5		24.2	12	
4	Part 4	800	800	800	-	800	-	1.5		22.3	9	
5	Part 5	800	800	800	800	800	800	3	-	21.1	5	
SUM								16				

- This experiment has medium vibrations and relatively low temperature and it takes reasonable time to finish the process .
- Measuring units
  - Motors from 1 to 6: Pulse per revolution
  - DC motor: RPM
  - Time: Minutes
  - Temperature: Celsius
  - Vibrations: mv

Table (5) the Second experiment in the process of decoding parts to determine the optimal time for maintenance

C) Third Experiment

NO	Items	M1	M2	M3	M4	M5	M6	T	DC	Tem	Vib	Notes
1	Part 1	6400	6400	6400	-	6400	-	3	140	20.4	16	The fifth part, which is the stage of removing the parts from their and placing them in the place designated for them
2	Part 2	6400	6400	6400	-	6400	-	3		23.6	19	
3	Part 3	6400	6400	6400	-	6400	-	2		26.2	13	
4	Part 4	6400	6400	6400	-	6400	-	1.5		25.3	17	
5	Part 5	6400	6400	6400	6400	6400	6400	2.5	-	24.1	9	
SUM								12				

- This experiment has high vibrations and high temperature and it takes little time to finish the process but the vibrations and temperatures make this inefficient and waste the equipment.
- Measuring units
  - Motors from 1 to 6: Pulse per revolution
  - DC motor: RPM
  - Time: Minutes
  - Temperature: Celsius
  - Vibrations: mv

Table (6) the Third experiment in the process of decoding parts to determine the optimal time for maintenance

3.11.1 The results of the three experiments during the process of unwinding :

Table (7) shows the time of executing the process of decoding the parts during the three experiments, and that is at different speeds for the DC motor responsible for the unwinding process. We also note that when the DC motor speeds change, the total time to carry out the operation changes with it, and here we find that there is an inverse relationship between the DC motor Si and time.

But there are other factors that are affected by reducing the time of the unwinding process, such as vibration and temperature, as the optimal choice for a DC motor is at a speed of 120 RPM at a time of 16 minutes, and that time and speed were chosen based on the tables that were previously analyzed for vibration and temperature analysis.

Figure (17) shows a graph of the three experiments of the unwinding process between the relationship of time per minute and the speed of a DC RPM motor.

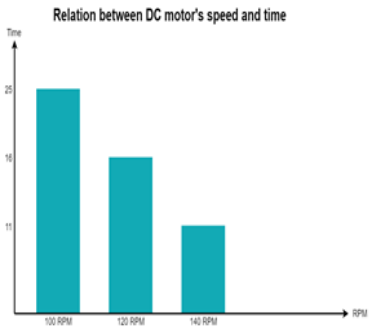


Figure (17) shows a graph of the three experiments of the jaw process

Time Minutes	DC motor RPM
25	100
16	120
11	140

Table (7) the relationship of the DC speeds to the time change in the unwinding process

3.11.2 Experiments of installing parts for the car to choose the optimal time

- **Installing parts to car**

A) First Experiment

NO	Items	M1	M2	M3	M4	M5	M6	T	DC	Tem	Vib	Notes
1	Part 1	200	200	200	-	200	-	7	100	18.3	11	The fifth part: which is the stage of installing the parts and placing them in the place designated for them
2	Part 2	200	200	200	-	200	-	6.5		19.1	12	
3	Part 3	200	200	200	-	200	-	6.5		20.5	12	
4	Part 4	200	200	200	-	200	-	6		21.3	8	
5	Part 5	200	200	200	200	200	200	8	-	22.1	2	
SUM								34				

- This experiment has low vibrations and low temperature but it takes long time to finish the process .
- Measuring units
  - Motors from 1 to 6: Pulse per revolution
  - DC motor: RPM
  - Time: Minutes
  - Temperature: Celsius
  - Vibrations: mv

Table (8) the first experience in the process of installing parts to determine the optimal time for maintenance

B) Second Experiment

NO	Items	M1	M2	M3	M4	M5	M6	T	DC	Tem	Vib	Notes
1	Part 1	800	800	800	-	800	-	3.5	120	19.8	10	The fifth part: which is the stage of installing the parts and placing them in the place designated for them
2	Part 2	800	800	800	-	800	-	3		20.7	12	
3	Part 3	800	800	800	-	800	-	3		22.5	9	
4	Part 4	800	800	800	-	800	-	2.5		23.4	11	
5	Part 5	800	800	800	800	800	800	6	-	22.3	6	
SUM								18				

- This experiment has medium vibrations and relatively low temperature and it takes reasonable time to finish the process .
- Measuring units
  - Motors from 1 to 6: Pulse per revolution
  - DC motor: RPM
  - Time: Minutes
  - Temperature: Celsius
  - Vibrations: mv

Table (9) the Second experience in the process of installing parts to determine the optimal time for maintenance

C) Third Experiment

NO	Items	M1	M2	M3	M4	M5	M6	T	DC	Tem	Vib	Notes
1	Part 1	6400	6400	6400	-	6400	-	3	140	21.2	15	The fifth part: which is the stage of installing the parts and placing them in the place designated for them
2	Part 2	6400	6400	6400	-	6400	-	2.5		22.5	18	
3	Part 3	6400	6400	6400	-	6400	-	2.5		24.9	12	
4	Part 4	6400	6400	6400	-	6400	-	2		26.2	19	
5	Part 5	6400	6400	6400	6400	6400	6400	5	-	25.1	12	
SUM								15				

- This experiment has high vibrations and high temperature and it takes little time to finish the process but the vibrations and temperatures make this inefficient and waste the equipment.
- Measuring units
  - Motors from 1 to 6: Pulse per revolution
  - DC motor: RPM
  - Time: Minutes
  - Temperature: Celsius
  - Vibrations: mv

Table (10) the Third experience in the process of installing parts to determine the optimal time for maintenance

3.11.3 The results of the three experiments during the installation process:

Table (11) shows the time for executing the encoder parts installation process during the three experiments, with different speeds for the DC motor responsible for the installation process. We also note that when the speed of the DC motor changes, the total time to perform the

operation with it changes, and here we find that there is an inverse relationship between the DC motor and the time.

But there are other factors affected by reducing the time of the winding installation process, such as vibration and temperature, the optimal choice for a DC motor is at 120 rpm in a time of 18 minutes, and that time and speed is based on the tables previously analyzed for vibration and temperature analysis.

Figure (18) shows a graph of the three experiments of the fitting process between the time-per-minute relationship and the speed of a DC RPM motor.

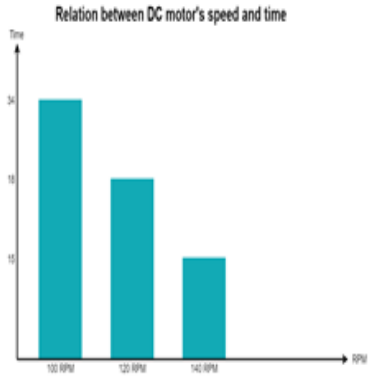


Figure (18) shows a graph of the three experiments of the Installation process

Time Minutes	DC motor RPM
34	100
18	120
15	140

Table (11) The relationship of DC speeds to the time change in the installation process

3.10 RESULTS :

1- Through the designed Mica Troni system, a designed model with improved quality has been achieved through which a large saving of time can be achieved in maintenance, which was wasted in the traditional maintenance operations followed in the auto maintenance service centers.

2- The application of the designed system (Mica Troni) in the maintenance of cars is not an end in itself, but a means by which to reach the objectives of automated maintenance for cars represented in achieving customer satisfaction and then achieving a competitive position and staying in the market.

3- Improving the quality of maintenance in the car engine and continuously improving it is one of the most important advantages of automatic maintenance, which can be applied in all auto service centers in order to stay in the market to achieve distinction in competition and gain customer satisfaction.

4- A large amount of cost has been eliminated in the maintenance of the car engine (the engine fuel cycle), some automated maintenance is applied by the designed system (mecha troni), and we find that the application of this system in a more accurate way is inversely proportional to the cost of maintenance, meaning that the more automatic maintenance is done by the designed system, The lower the maintenance cost, which affects both companies and customers.

5- Achieving the greatest customer satisfaction in the maintenance of the car engine (fuel cycle) by improving the services represented in reducing the time to complete the maintenance process (cost). Also, customer satisfaction is one of the important and basic pillars of the automatic maintenance goals that are implemented by the Mica Tron system.

3.12 Conclusions :

1- The multiplicity of the term maintenance and repair in many sciences and knowledge in all related works, closely related to industrial and production institutions, as the meaning of the term maintenance differs according to the medical nature of the work in the facility.

2- Maintenance is characterized by its wide application in the field of achieving harmonization between the working personnel according to the characteristics of their skill specifications and their work environment, as maintenance and repair are considered an input from the entrances to the design of work systems, which by following the system becomes easier for the workers.

3- Poor experience and knowledge of workers in the field of study (car maintenance centers) of programmed maintenance methods, in car maintenance work.

4- The mismatch between the automated programmed maintenance and the workers in maintenance centers leads to negative consequences for maintenance work.

5- Poor experiences and knowledge of technical education students towards getting to know many parts of the car engine.

6- The technical education students need a lot and the number of actual observations on a continuous basis, to quickly acquire some maintenance skills.

7- Many auto maintenance service centers depend on traditional mechanical maintenance, by means of mechanical tools and tools, and some other auto maintenance service centers depend on some mechanical hydraulic and pneumatic systems using traditional methods.

3.13 RECOMMENDATIONS :

In light of the current research results, the researcher recommends the following :

1- The need to pay attention to the process of continuous improvement in car maintenance operations.

2- The use of the designed system (Mica Troni) in many car maintenance operations.

3- In automobile workshops for diploma students in industrial secondary schools, the three-year system, specializing in cars, recommends the existence of multiple modern Mica Tron systems to train students on to keep pace with the labor market.

4- The introduction of the designed system (mica troni) to train diploma students on car maintenance skills (engine fuel cycle).

5- The necessity of training students in industrial schools, as well as workers in auto maintenance service centers, on the skills of dealing with modern programmed systems.

6- The necessity of training students in industrial schools on the skills of dealing with computers and the Internet in an era known as the era of technology.

7- Industrial technical education schools use the programmed automated maintenance systems to teach students the maintenance and repair course instead of the traditional maintenance systems.

8- Preparing students of industrial technical education schools to deal with the designed system (Mica Troni) to make automatic maintenance for cars.

9- Training of faculty members (industrial education teachers) on the programmed systems to deal with the system designed for maintenance work (Mica Troni system).

10- The necessity of using simultaneous and asynchronous interaction tools over the Internet in teaching students, in addition to face-to-face interactions that increase students' motivation for learning.

11 - The importance of practical training in the workshops to provide students with the scientific and educational skills for car engine maintenance .

12 - The importance of combining different methods, which are modern electronic methods, and traditional methods of education, in order to obtain the greatest effectiveness of the educational process.

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REFERENCES:

[1] Frederick and others, “Automated Vehicle Technology”, General Organization for Technical Education and Vocational Training, Saudi Arabia.

[2] William Krause, "Auto Mechanics", Publications Agency - Kuwait, Dar Al-Qalam - Beirut, (1977 AD).

[3] Abdel-Rahman Tawfiq, Maintenance and Facilities Operation Department, 3rd Edition, Management Professional Expertise Centers "MEC", 2003, p.8.

[4] Al-Taie, Youssef Hajim and others (2009), Quality Management Systems in Productive and Service Organizations, Al-Yazouri Scientific Publishing and Distribution House, Jordan, Amman.

[5] Shawqi Naji Jawad: Business Administration - A Holistic Perspective - Al-Hamed Publishing and Distribution House and Library, First Edition, Amman, 2000, p. 479.

[6] Khaled Abdul Rahim Al-Hiti and Others: The Basics of Industrial Organization, Zahran Publishing and Distribution House, Amman, 1997, p.152.

[7] Muhammad Ahmad Al-Muqaddam (1997) Preparing a program in education technology based on competencies and determining its effectiveness using the individual learning approach for students of Faculties of Education, PhD Thesis, College of Education, Al-Azhar University, (1997).

[8] Hassan Abdullah Al-Tamimi: Production and Operations Management - A Quantitative Introduction - Arab Thought House, First Edition, Amman, 1997, p. 131.

[9] Rami Hekmat Fouad Al-Hadithi and others: recent trends in programmed maintenance management, Wael Publishing and Distribution House, First Edition, Amman, 2004, p.16.

[10] Sami Mazhar Qantqji, Rationalization of Maintenance Operations by Quantitative Methods, Dr. Sami Mazhar Qantqji Center for Business Development, Syria, 2003.

[11] Adel Hassan, Industrial Organization and Production Management, University Youth Foundation, Alexandria, 1993.

[12] Tommy Miloud, Maintenance and its Impact on Production Costs, Master Thesis, Department of Planning, Institute of Economic Sciences, University of Jazaire, 1992.

[13] Ashour Mazriq, Faculty of Economics and Facilitation Sciences, 2003.

[14] Fawzi Shaaban, mentioned, Department of Maintenance and Industrial Security, Cairo University Center for Open Education, 1999.

[15] Nasser Dadi Adoun, Economy of the Corporation, 2nd Edition, Muhammadiyah Public House, without publication.

[16] Muhammad Jaber Khalaf Allah Ahmad (2003) The Effectiveness of the Micro-Teaching Method in Developing the Skills of Maintenance of Educational Devices among Students of the Education Technology Division of the College of Education, Al-Azhar University, Master Thesis, College of Education, Al-Azhar University.

[17] **www.TKNE.com** Arif Mohamed Soliman, Preventive Maintenance of the Facility, Technical Forums 2-4-2006

[18] Y.Lavina : Audit de la maintenance, les éditions d'Organisation, Paris, 1994, P 14.

[19] H.Bernard : Entretient et maintenance, édition EYHOLIOS, Paris, 1974, P 84.

[20] G.Bosser et J.M.Guillard : Maintenance des systèmes de production, les éditions FOUCHER, Paris, 1990, P 170.

[21] Ashcrofi, E., and Manna, Z. The translation of'GOTO' programs to 'WHILE' programs. Proc. 1971 IF1P Congress, Ljubljana, Yugoslavia, Aug. 1971, pp. 250-255. Demonstrates that every flowchart program can be written without GO TO statements by using WHILE statements.

[22] Halstead, M.H. Elements of Software Science. Elsevier North- Holland, New York, 1977. Halstead investigates the natural laws that govern the construction of programs and presents some measures of the effort required to write and understand programs.

[23] J.C.Francastel : : Ingénierie de la maintenance – de la conception à l'exploitation d'un bien -, DUNOD, Paris, 2003, P 466.

[24] F.Monchy : La fonction maintenance – formation à la gestion de la maintenance industrielle -, MASSON, 2 ème édition, Paris, 1996, P 181.

[25] R Keith Mobley, "Maintenance fundamentals", Elsevier Butterworth – Heinemann, USA, (2004).

[26] B S Dhillon, "Engineering maintenance – A modern approach", CRC Press, USA, (2002).

[27] Mustafa Bahattin Celik and Bulent Ozdalyan, "Gasoline direct injection", Turkey, **www.intechopen.com.**

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