Chapter

Training by Projects in an Industrial Robotic Application

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Abstract

This chapter presents a case study of learning environments that generated a technical description of the reconditioning and commissioning of an industrial robotic arm, specifically from electronic control, mechanical design, and its application in kinematics and programming, as a pedagogical tool that powers education training. Topics are developed in a didactic way in the research hotbed such as the technology implemented to recondition the arm, the modifications that were made in terms of electrical and electronic capabilities, the analysis of the initial state of the existing electrical elements, the new devices to be implemented, and necessary calculations for the reconstruction and adaptation of the arm from the electro-mechanical point of view. It is actually the best way to promote research in the training of the student in the classroom, taking the initiative to access knowledge with the guidance of the teacher to understand the information related to the problem to be solved. The project method allows me to strengthen learning and especially the construction of knowledge of the dual relationship, SENA academy—business and theory—practice, as a training model.

Keywords: robotic arm, knowledge, kinematic, learning environments, research, repowering

1. Introduction

The progress of a country's industry consolidates on a technological basis made up of milling machine tools, lathes, loading robots, and robotic arms [1]. The reason for launching this statement base on the efficiency of the development of manufacturing processes since the greater the number of high-quality products produced in the shortest possible time, the lower the manufacturing cost [2]. Additionally, in [3], the development of robots for production process in the food industry is presented; in 2015 with [4, 5] the importance clarify not only of the implementation of robots in the industry but of how they integrate and interact safely with humans in different industrial processes and 2016 in [6]. The concept of hybrid equipment presented as a new form of industrial revolution through the use of robots equipped with new forms of technology and artificial intelligence to work alongside human beings.

In this same line, SENA through the GACIPE group belonging to the CTMA (Center for Advanced Manufacturing Technology), in the last 3 years has been developing different projects related to intelligent manufacturing systems, appropriating the appropriate management of the technology that usually work has been done worldwide on machine tool projects such as CNC machines and robotic arms of industrial order.

The educational approach of SENA of an institution with technical and technological programs such as SENA is education for work, and that is why the realization of projects such as these, of great importance with a high technological, scientific and research index, becomes a necessary and innovative support process that allows a student to interact with a robust element, which he may have to face in his work life, and which is not normally easily accessible to him; In most cases, these items purchased with large budgets are considered materials of unique manipulation by experts. However, through this methodology based on social constructivism pedagogy, the active participation of students from the beginning of the research process, encouraging their creativity, curiosity, and analysis capacity, allows them to achieve the structuring of possible solutions for the obsolescence of different teams they can face in their working life.

Therefore, the objective of the project was to promote the research capacity and the development of technological solutions from the repowering of the industrial robotic arm in order to allow interaction between teachers, students, and the business sector, with a view to strengthening applied research, the development of the ability to work in groups and interdisciplinarity and the promotion of a culture of learning.

2. Methodology

The project method was implemented, which consists of a training strategy that articulates a set of activities to solve one or several problems in the real context [7]. The realization and development of the project had a specific problem the repowering of an industrial robotic arm, which required the participation of some teachers, students, led by the research group with experience and knowledge in the subject of machines and tools, taking advantage of a real need that strengthens the student and future professional of SENA and count on the linkage of the company as part of the development of the research processes.

The execution of the proposal based on the principles of social constructivism in which the formulation of a solution strategy proposed by the student and the teacher plays a mediating role, the technological means are the tools for its operation and the didactic instrument is the industrial robotic arm [8].

The strategy implemented was carried out following the following: diagnostic, planning, intervention, and socialization phases.

The participants of the project were three members of the GACIPE research group (SENA Center for Advanced Manufacturing Technology). The members are the project director, and the leaders of the two research seedlings SIMAN and SIE. The members of the two seedbeds also participated. The SIMAN seedbed linked seven students of the Technology in Design of Mechanical Elements for its Manufacture with CNC Machine Tools. The SIE seedbed linked seven students of Industrial Electricity Technology. Finally, the company participated with the owner and some employees designing and building some pieces required in the project.

3. Conceptual framework

3.1 Learning environments

They are educational scenarios where favorable conditions of learning exist and develop, and that is not limited to the material conditions necessary for their implementation, but are shaped by the dynamics of the educational process from the development of actions, lived experiences, attitudes to material and socio-emotional conditions, relations with the environment and infrastructure [9].

3.2 Knowledge

It is a process of interaction between the subject and the medium, but the medium is understood as something social and cultural, which also involves the physical. The construction of knowledge is achieved from the moment the student constructs meanings in a structured environment and interacts with other people intentionally [10].

3.3 The social constructivist pedagogical model

It is a pedagogical model based on the interaction and communication of students and the collective construction of knowledge. The student is the result of the historical and social process. The language plays an essential role. The evaluation is dynamic. The teacher performs the role of mediator and supports the process based on his experience [11].

3.4 Project training

Project training classified as inductive teaching methods focused on student and active learning since the beginning of the training process. During the process proposed as a challenge, a problem stimulates student learning and gives him the responsibility before his process, requiring an effort of discussion and resolution of problems from the beginning of the project. The idea of constructivism is that in the formative process, the protagonist is the student who builds his knowledge from his own experience being more enriching [12]. This method developed in phases or stages such as: make a diagnosis, determine a problem, plan activities to solve it, execute them, and evaluate (socialize) them.

4. Project description

The equipment to be intervened is a robotic industrial welding arm of reference MR-2000 manufactured in 1995 by the MILLER company, and it has six degrees of freedom and weighs approximately 160 kg. Said arm provided its services last century and for different factors such as deterioration of its connections, the lack of maintenance, the obsolescence of its control system based on old processors, and the outdated electronics, were out of service.

4.1 Diagnostic stage

A technical diagnosis applied in the SENA facilities by research professors of the GACIPE research group, where a large part of the robot needed an update and their electromechanical systems had to be replaced; however, the diagnosis threw in front of the structure was stable and with high possibilities to work on her making some adjustments. This mechanical arm structure then becomes an excellent candidate for reconditioning and repowering devised for the project, which makes it a perfect mechanism for a pedagogical and research process.

When mentioning the possibility of integrating pedagogical processes into the project, the need for seedbeds to support the research process of the GACIPE group is emphasized, allowing the support of students from different technologies in the training areas related to the needs of the project, allowing then to implement the proposal of design and development of a new and reliable control system, by integrating a series of fully updated electrical and electronic devices, which allows us to perform a perfectly scalable assembly at industrial and plausible level as training, experimentation, and interaction tool for students from different areas of training (faculties), related to students in electronics, electricity, electromechanics, and programming.

4.1.1 Creation of the work team

In the robotic system, devices or mechanisms, such as some couplings and the entire frame, including the base, work well. However, all electronics, electromechanics, and software are obsolete. Therefore, an interdisciplinary team is needed to achieve the success of the project. Each team destined for a particular section according to their strengths. The development lines are mechanical, electromechanical control, and programming. Each team is made up of instructors and students of SENA to know first-hand what is a process of reconditioning of industrial machinery. Each team must carry out research work to apply their knowledge acquired on a real high-level project. It notes that periodic meetings of the GACIPE research group were held to make the fundamental decisions of the process.

4.1.2 Case study

The initial state of the arm is shown in **Figure 1**.

The initial state of the electrical panel and the original control are shown in **Figure 2A**, **B**.

Therefore, taking into account the initial situation of the robotic system, a brief diagnosis was made.

- Microprocessor-based technology of the 1980s of the last century.
- The control system is a mixture of digital and analog components. That is, it is not modular.
- The size of the power system is excessively large and heavy.
- The monitoring software is an old and discontinued version. That is compatible with the first versions of operating systems.
- The man-machine interface has destroyed half of the screen. There is no current replacement version.
- The structure and most of the mechanisms are in good condition. It should only do piece-by-piece maintenance due to its long inactivity.

Consequently, the decision is made to implement new technology (electronics, software, and mechanics) compatible with the existing structure and mechanisms for the execution of arm kinematics.

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4.2 Planning stage

At this stage, the activities that must be carried out to meet the objective of the project are determined. The intention is to recover the original functioning of the robotic arm. That is why we study each technological module of the robot to have

Figure 1.
The initial state of the arm.

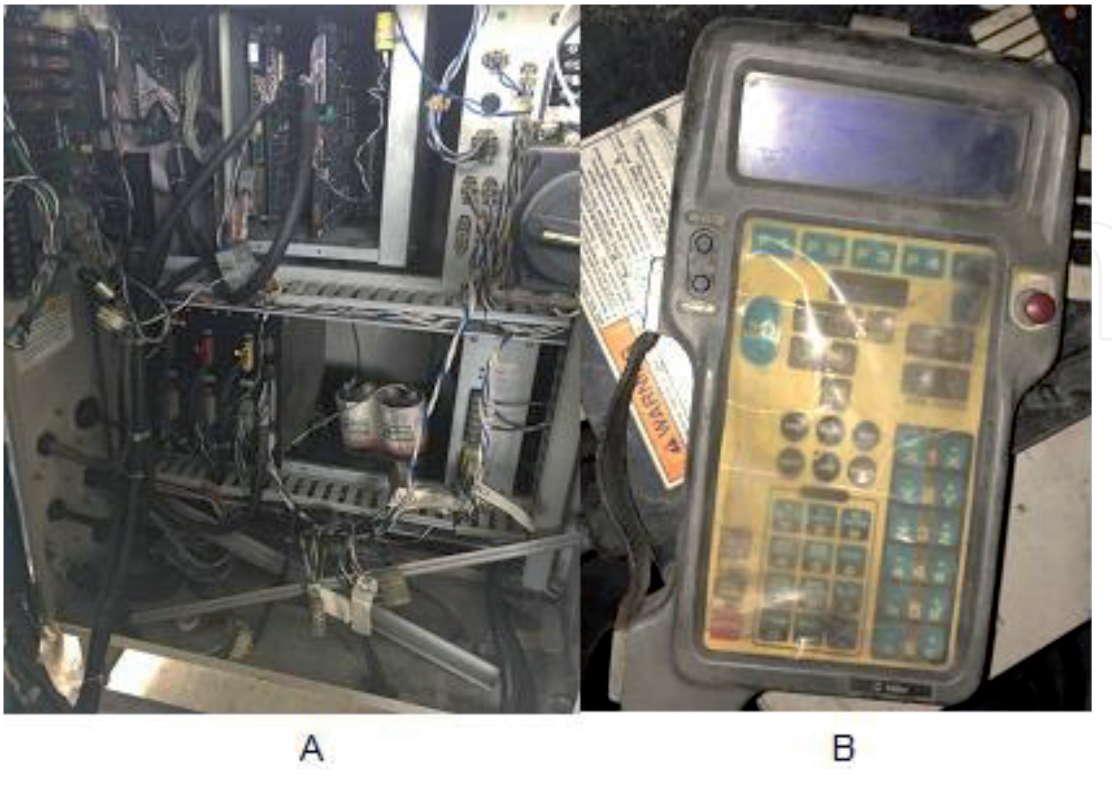


Figure 2.
Module status: (A) control panel and (B) man-machine interface.

the detail of the problems that must be overcome. Therefore, each of the modules will be presented below.

4.2.1 Control module

The original cabinet was completely revised. The diagnosis of electronics is that the circuitry is in proper operation. However, its architecture is complex. There is a mixture of digital and analog elements. Some of those elements or components are obsolete or are outgoing. Even some of them are expensive. It is no longer being manufactured.

Therefore, the entire control cabinet was designed and constructed mainly with the objective of protecting, controlling, and indicating the status of the servo-drivers and the PC that are in charge of the control of the arm, for these different control devices were used, maneuver and protection such as selectors, breaker, electrical noise filters, thermal and overcurrent protection relays, sources, and light indicators among others.

The final control cabinet (**Figure 3**) was designed and built by apprentices and instructors who are part of the power seedbeds. Servo drivers are products offered by DMM. These products were successfully tested in previous projects.

The main components used in the control panel are: Driver DYN4-H01A2-00, Driver DYN2-TLA6S-00, and Computational Hardware 5I25 Superport FPGA based PCI.

The ignition cycle is as follows: when the main breaker is switched on, the system does not start; everything starts when the main contactor is activated, and the coil is activated from the system computer, before this, in order to start the computer. The control board has a power button on the door, this button is responsible for short-circuiting two pins of the PC board (PWR) to generate the ignition

Figure 3.
Control board.

of said card, and additionally this board has a power signal that activates the main contactor. At that time, the entire board is energized, initializing the sources, servo drivers, and other components.

4.2.2 Power module

Within the exploration and research work that was to be carried out, a technological surveillance activity was carried out looking for technologies similar to the original actuators of the arm in commercial, technical, and academic websites on the Internet with the students of electric seedbed that focused on the definition of power system and the determination of the suitable motors, in such a way that the arm meets or improves the original response level, in this particular case, six servomotors had to be selected, three of them, more robust (1 kW) to take care of the movement of the joints responsible for positioning, and three other smaller ones (0.12 kW) responsible for handling the grabber.

The servomotors were chosen to take into account the characteristics of the original engines, the main power, size, and electrical characteristics were reviewed to find a suitable replacement, as for the brand the DMM brand was selected for its reliability demonstrated in previous projects developed for the industry by the GACIPE research group. The servomotors used are Servomotor 410-DST-A6TKB and Servomotor 11A-DST-A6HKB. The servo drives used for the control of the servomotors are DYN4-H01A2-00 and DYN2-TLA6S-00. These drivers have within their basic applications, being implemented in machine tools, with RS232/Modbus RS485/CAN communication.

4.2.3 Robot programming

During the review of the robot, it could be evidenced that the software is obsolete and not functional with the current operating systems in force. As for the electronic infrastructure, both the man-machine interface and the control system are eliminated because their components have already left the commercial market.

To select the control software, a state of the art is done in academic pages and databases on the internet with the support of the students. Among the results, it was found that some of the existing programs in the medium are made by other people who, not finding a good option for this application, choose to design and build their own software as mentioned in [13–17], where there is an open architecture but with a lot of work to develop, in this search is the aforementioned LinuxCNC, a software based on the Linux operating system Ubuntu V10.04 (**Figure 6A**), which implements an open architecture for numerical control of CNC machines based on the RT-Linux kernel for real-time instruction execution. Some work done with the software shows good results as in [18]; therefore, the decision is made to select the free LinuxCNC software.

The servomotors are controlled by signals from an FPGA 5i25 card, a low-cost and general-purpose device for PCI, commonly used in this type of applications, which allows us to use pins and parallel port connectors to handle high compatibility with the most actuator motion systems becoming a reliable parallel port-type interface, works perfectly at 5 or 3.3 V, has 34 I/O bits with their respective pull up resistors, this card is installed on a motherboard GA -H110M integrated in the control cabinet, said board controls, through a hardware interface, the movement of the robot, using the free LinuxCNC software, for its robustness, additionally so that the apprentices know about it and include it in their project due to its advantages as a very versatile, reliable, and efficient software to handle CNC machine tools.

For the positioning of the robot, inductive proximity sensors (PNP LJ18A3-5-Z-HQ) have been located at the start and endpoints of each joint, information that is supplied to the LinuxCNC software.

Although this system has two sensors per joint, the arm is controlled by an open-loop control system supported by LinuxCNC software. The software initially requires the "home" sensors at initial start-up and by previously configuring the actuator step, step pulse, and motor speed. This software interprets the current position at all times according to the initial configuration. To have a correct and calibrated displacement, several trial and error tests performed by the trainees were required to move the arm as accurately as possible about the software and the instructions sent.

4.2.4 Robot structure and mechanisms

The robot presents a series of mechanical faults. The base of the structure does not have the servomotor or the couplings with its respective axis. Servo motors for grabber positioning do not have motion transmission belts. The limit switches for the different joints are not functional.

4.3 Intervention stage

For the development of the robotic arm repowering process, it was possible to develop a plan followed by an order of steps necessary for the execution of this process. Therefore, the following aspects were carried out.

4.3.1 Collection of bibliographic tools

Initially, the search was made for textual support material that includes documentation of the original robot model. Thus, there is clarity in the behavior and functions of the robotic arm.

Taking into account the information collected and the current state of the robot, it has been possible to have more clarity in the planning of the arm repowering process to achieve the objective of recovering the initial characteristics and conditions.

In addition, in this phase, there was an intense work of the apprentices of the electricity hotbed for obtaining the required information by configuring a brief state of art about publications of other works in the last 2 years, whose central theme is pedagogical robotics or educational robotics through the metasearch engine Scopus. This is how [19] refers to robotics in education as the appropriate option to increase the efficiency of the formation of research competencies in school studies; in [20], it goes further as robotics learning is considered as the pretext to involve multiple disciplines from the humanities, social sciences to mathematics and engineering that encourages creativity, while in [21], it not only states that the subject of robotics is attractive to students but also poses an evaluative methodology training for teachers taking into account the great complexity of the multidisciplinary theme of robotics is addressed by a cybernetic model of pedagogical feedback, collaborative learning, and empathy; and in [22], a model of robotics in education applied in classrooms of the local education system is presented, where we want to cover the needs of the current society and strengthen students' knowledge. Additionally, we have found a series of articles dedicated to the study of multiple works on educational robotics, pedagogical robotics, social robots, and the technologies used, reviewing different databases and metasearch engines such as web of science, Scopus, Science direct, IEEE, among others spanning periods ranging from the last 5 years to the last decade, this type of publications allows to have more condensed information on the contributions developed and show trends in the research processes [23–25], not only focus In the student's response they also discuss the teacher's role.

In this phase of the project certain findings and expressions of the seedlings were found as:

Understanding the search formula is essential to access quality information.

The Scopus metasearch engine converges the databases of the scientific world.

The selection of information is vital for the creation of a state of art of great quality.

The consolidation of state of the art depends on the number of items covered.

Review and survey articles are a fundamental pillar of art states.

These types of situations and possible conclusions determine the degree of commitment of the apprentices in their eagerness to apply the state of the art technique and access the best possible knowledge provided by the scientific world.

4.3.2 Design and manufacturing process of couplings and mechanical parts

In the initial maintenance of the robotic arm, it develops the design and modeling of each of its parts to later model each of the missing mechanical parts for the repowering process (**Figures 4** and **5**).

In this activity, the research seedbeds of the areas of electricity and manufacturing systems were the main support by disassembling the arm and identifying missing parts following the protocol found in the user manual of the robotic system.

During this phase, it was then possible to correctly develop each of the missing or next pieces to be modified by the dimensions of the new engines, thus maintaining the full functionality of the robotic arm and without compromising the movements in each of its axes.

As can be seen in **Figures 6** and **7**, the detailed design and modeling was required for each of the couplings present in the arm joints (axes), in which it is necessary to change each of the engines due to the obsolescence of its drivers, thus maintaining a control of each joint and identification in the process of advancement and mechanical development. In this aspect, the apprentices belonging to the seedlings carried out academic design and modeling exercises for each of the pieces that allowed them to strengthen their competences, an activity that was developed in parallel with the design work developed by teachers with the robot structure.

Figure 4.
Practical presentation: (A) student and (B) administrative.

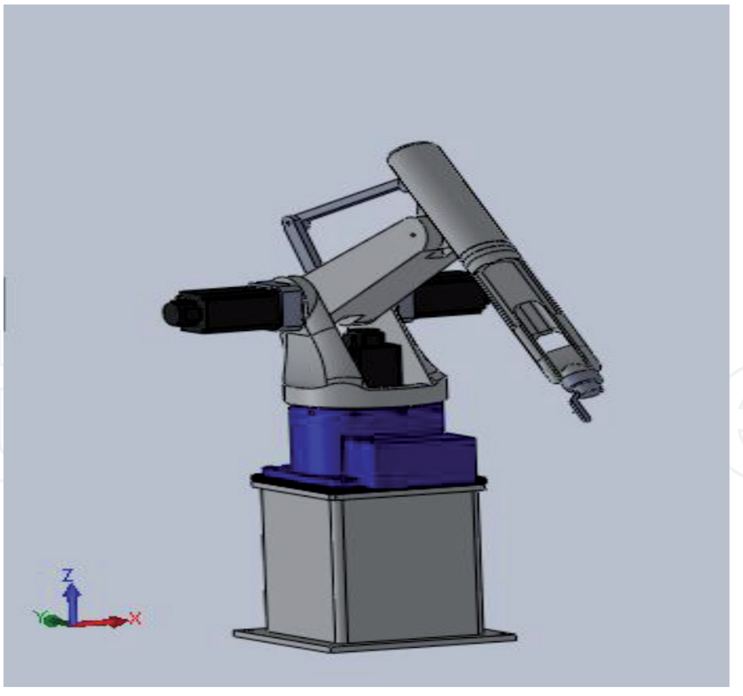


Figure 5.
Robot arm model.

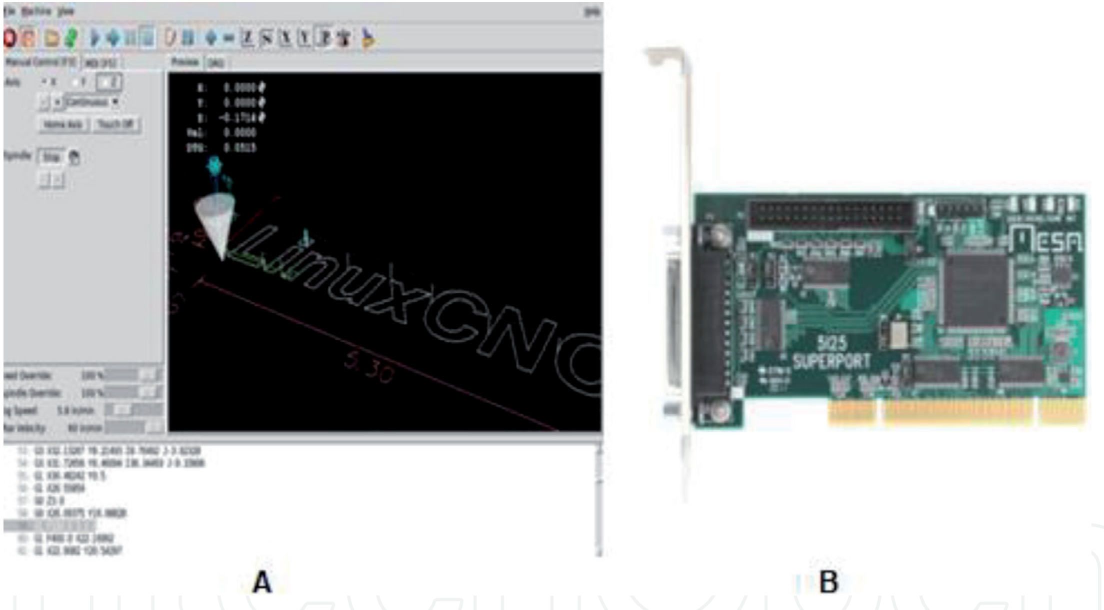
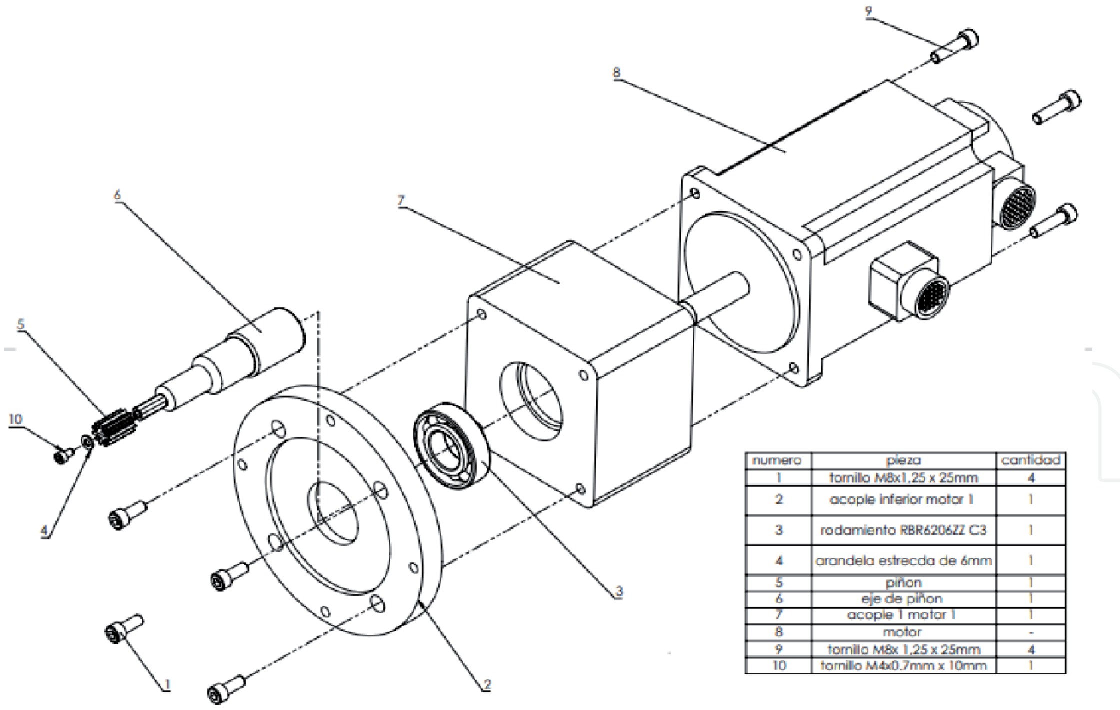


Figure 6.
Control system: (A) LinuxCNC platform and (B) FPGA 5i25 card.

Additionally, it is possible to export each of the pieces to be elaborated to a CAD program and thus start with the process of elaboration of each one of the programs for the machining routes, then the coding of its trajectories and manufacturing in machining machinery by starting of shaving (lathe, milling machine) either conventional or CNC-controlled, and the process of testing the couplings and parts in the workplace begins. In this regard, some simple pieces are developed and evaluated by the apprentices who are part of the workgroup.

In this component of the project, there are certain aspects and responses of the seedbed apprentices who showed at the meetings:

The apprentices of the advanced manufacturing seedbed strengthen knowledge in design and modeling software.



numero	pieza	cantidad
1	tornillo M8x1,25 x 25mm	4
2	acople inferior motor 1	1
3	rodamiento RBR6206ZZ C3	1
4	arandela estrecda de 6mm	1
5	piñon	1
6	eje de piñon	1
7	acople 1 motor 1	1
8	motor	-
9	tornillo M8x 1,25 x 25mm	4
10	tornillo M4x0.7mm x 10mm	1

Figure 7.
Coupling model.

When the exploded drawing of the robot was made, it was brutal to learn the different standards of the technical drawing.

The handling of machine tools has allowed us to use different metrology procedures and to know the technical norms of the manufacturing area.

The consolidation of knowledge for the use of machine tools has allowed dimensioning the procedures for machining and finishing the parts.

4.3.3 Control and power module

The technical specifications and the operating mode of both the control module and the power module are described in this section.

The board is powered by three-phase voltage, and it uses the ground and neutral signal at all times since it must power the internal lighting and the computer installed inside, both the CPU and the display (Interface). A filter is installed for each line (FN610-10-06), which provides good symmetric and asymmetric attenuation performance with high saturation resistance and excellent thermal behavior, thus having a safer system that can meet the final application need to mount on the arm (avoiding possible complications in the case of electrical noise or arc welding equipment).

This system has a fuse bank (10A-5A-2A), used to protect the board from different sides and independently. For the line that feeds the computer, an additional filter (110–220 V 6EHT1) is installed, which allows for a cleaner signal that does not affect the interaction of the arm with the computer processing. Rail terminals were also mounted (with their brakes) and a distribution terminal block for different connections such as sensors and three-phase lines, making the board more orderly and easy to review for students.

The system has protective breakers, including a three-phase, which goes directly to a contactor (three poles 240VAC-001A18NA3) that energizes the board in general. Before each servo-driver, a motor guard was installed (Gv2-me16c 9-14).

The motor guard prevents unbalance in three-phase lines. The brake of the servomotors is activated by four relays.

It also installed 3 DC sources of 48 V to 7.5 A, a dedicated source for each servo-driver that controls the 0.12 kW motors, an additional 24 V DC source (for motor brakes) and a 12 V DC source (for the control).

At this stage, the electricity seedbed apprentices supported the researchers in the interpretation of plans and assembly of their components, which is how the meetings presented some findings and conclusions about the experience.

The assembly of the control cabinet is an activity for the appropriation of the technical standards of electronics and electrical.

The manipulation of the components of the module and the verification of its correct operation were the functions performed during the assembly of the cabinet.

There was care in the functional tests of the control and power module. An improper maneuver can cause the malfunction of any of the components that could lead to permanent failure.

4.3.4 Coding development robot arm

Once the electrical, electronic system, the mechanical system and the successful completion of the motion tests have been reconditioned with each independent degree of freedom, the software for the positioning of the grabber conditioned from the simultaneous movement of all the motors to this procedure known as the development of the kinematics of a six-axis industrial robotic arm [26]. In this regard, students completed training in the fundamentals of physics, geometry, and trigonometry to have the basic knowledge that allows them to understand the calculations and equations that govern the kinematics of an arm.

The position of the robotic arm is known with the mathematical expression of the inverse kinematics and direct kinematics. It should be noted that the robotic arm is a palletizer type. In databases, there is no information on kinematics for palletizers. Therefore, the kinematics of the robot was built and incorporated into the LinuxCNC.

In this regard, the students carried out state-of-the-art work related to kinematics in palletizing and serial robots to have as much information as possible to accelerate the assembly of kinematics in LinuxCNC software.

Through the LinuxCNC program, the use of the arm is allowed, either manually, independently managing each of its axes, or in a programmed way following a route or path already established by code G, thus facilitating the management process for an operator with basic knowledge in CNC coding and the area of machining.

In this process, the desired route is programmed in CAM programs, such as MASTERCAM among graduates or CNC HEEKS on the side of free programs. Initially exporting in a file (Parasolid, ages, and step), which is compatible with CAM machining programs to trace a path on which the robotic arm system should be guided.

Subsequently, the G coding is elaborated and then exported in the NGC format, with slight modifications in the program developed, so that it can be read correctly by the LinuxCNC interface and capable of being executed correctly.

In the same way, it can be programmed manually by initially acquiring the headings of the programs to follow and adding the routes in the coordinate axes of the Cartesian plane (x, y, z).

The factory application of the robotic arm was to weld parts of the automotive sector, currently, it has been repowered and conditioned to load heavy parts in the precision foundry industry.

In this phase, the students of the electricity hotbed and the manufacturing hotbed supported the design and implementation activities of the G code in the LinuxCNC to monitor the behavior of the robotic arm in its positioning in the *XYZ* plane. Additionally, the trainees started from their initiative to solve the problems, and the investigating instructors guided the students to improve the activities with the robotic arm. Then, pedagogy influences students. Therefore, the aspects that are highlighted at this stage are presented below.

The appropriation of CAM technology in free software (HEEK CNC) and licensed software (MASTERCAM) allows us to understand the scope and limitations of the coding of the instructions on the CNC machine.

The LinuxCNC application presented an appropriate performance in the robot arm.

The type of application and the type of actuator in the grabber must be established for the proper functioning of the robotic arm.

Tuning the power devices (servo drivers) of the arm prevents the crashing of your joints.

4.4 Results stage

Once the robotic arm intervention process has been carried out successfully, it has been defined to socialize the scope achieved in the execution of the project. The intention is to present an exhibition of the work teams (students and teachers) that intervened in the process of repowering by making a technical description of their contribution and finally proceeding to perform a demonstration of the robotic arm performing a welding application. The socialization executed in two moments. The first was applied during the final tests of the robotic arm, during this time six groups of students were taken, each of 20 students from different areas of knowledge to the research workshop to witness the turning of the robot (see **Figure 4A**), in addition, the administrative area of SENA was invited to verify the progress and success of the process of repowering the robotic arm (see **Figure 4B**).

Figure 8.
Presentation of the robotic arm project to the academic community.

The second moment of socialization corresponds to the completion of the tuning of the robot. The presentation in the society of the robotic system is made. The invited public is the businessmen representing Mold Glass, owner of the robot, and students and teachers from the academic community of SENA-CTMA was also invited by virtual mass media (see **Figure 8**).

During this stage, the different actors (student, administrative and businessmen) agree to qualify the results of the project as satisfactory and of great impact for the industry due to the low costs and the high degree of precision of the robot's movements.

5. Discussion

In [19], there is a collaborative work between the students and the teacher in which the researchers' terms and functions are naturally involved; in the activities proposed in the execution of the project, there are no hierarchies and each one contributes from their perception and creativity, and robotics projects are part of the curricular activities. In [20], it proposes a course by stages for the development of projects with the robotic educational analysis of state of the art, implementation, pedagogical design, learning scenarios, pilot use, validation, and social evaluation, and this procedure is performed with students of schools. The way to maintain interest in the project is through the approach of ideas proposed by students, the development of skills, and socialization of results by different means including social networks, and in [21], a conductive and constructivist activities series used to identify the benefits of the strategy called collaborative learning is executed. This procedure has been developed by university students for 5 years. As the course develops, more and more complex challenges are proposed. It is also projected towards the preparation of teachers in the management of constructivist methodologies in robotics. Therefore, a group of teachers from Public high school is trained to work with robotics projects, to apply this methodology with their high school students, but in [22], a work of systematization of subjects was done with the aim of introducing the contents on robotics from the pre-school stage to the university level. This process was carried out during 6 years that had its starting point in a summer vacation program called "Technosphere." However, despite describing and explaining the way in which these works are carried out (all immersed in the curricula) based on problems that are solved in didactic robotic systems, it is not possible to find information about the impact of these projects on life of the students because it is important to know the lived experience of the members that enriches and feeds back the constituted process, which if they are found are generic results based on surveys and evaluations that can give an indicator on the evolution of the process, but the findings obtained from interviews, logbooks and daily books are tools that have valuable information about the process. In [23–25], more general information about educational robotics works focused on doing documentary research is expressed, which indicates the importance and importance in the field of education and pedagogy since these types of treaties have within from his study trends, perspectives, and even prospects, aspects that allow validating the possibility of doing research at the frontier of knowledge.

This project describes the work done with the research seedbeds (through extracurricular activities). Applying the principles of constructivist social pedagogy using as a strategy, the project method through technological development and applied research such as the repowering an industrial robotics arm of six degrees of freedom, in which its monitoring and verification of progress, has been carried out through technical reports, the observation guide, the field diary, finding not only the technical and technological advances of the robot but also the findings, conclusions, and experiences of the work teams (teachers and students) during the development of the different stages of the project.

6. Conclusions

The development and tuning of the repowering of the industrial robotic arm allow the consolidation of a research group for the solution of manufacturing machines based on the productivity of the industry, whose technology is vital to increase its competitiveness in international markets.

This process is very important from the pedagogical point because independent of the technologies or techniques used in the project, the effectiveness of the student's learning process can be corroborated by being immersed in this type of real projects that allow to appropriate the application of the method scientific, consolidate technological knowledge and know the fundamental tool like the state of art for the development of an applied investigation.

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