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# Educational Robotics Constructivism and Modeling of Robots using Reverse Engineering

David G. Maxínez, A. Ferreyra Ramírez, Ismael Echenique Álvarez, Francisco Javier Sánchez Rangel, Guillermo Castillo Tapia, Petra Baldivia Noyola, María Antonieta García Galván

***Abstract*—**The project describes the modeling of various architectures mechatronics specifically morphologies of robots in an educational environment. Each structure developed by students of pre-school, primary and secondary was created using the concept of reverse engineering in a constructivist environment, to later be integrated in educational software that promotes the teaching of educational Robotics in a virtual and economic environment.

***Keywords*—M**odeling, constructivist, engineering, reverse, robotics education, virtual, morphology.

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## I. Introduction

INFORMATION and communication technologies "computer, internet and telecommunications" have improved substantially the quality of life in our society and in a very interesting way the aspects related to education and the way in which knowledge are transmitted or obtained by the student; without losing sight of the economic aspect that could yield a problem of technological backwardness in the countries of Latin America, as a result of the growing development of high-tech educational materials, incorporated into the classrooms of first world industrialized countries.

Technological products of educational nature, gradually have taken over the market educational, industrial and consumption; Automation and specifically educational robots "Educational Robotics" [4], allow students inter alia to socialize and interact with machines equipped with a certain degree of intelligence.

Automation trends worldwide in the different services and activities of human beings: cashiers and boxes of prepaid vending machines candy and food, i/o in parking... etc., are just some examples of the "processes control" where coexistence between humans and machines is a reality [4], reason why the introduction of systems mechatronics at school levels from primary professional, are inherently transmit and disseminate the advances of science and technology in our age.

D. G. Maxínez, A. Ferreyra R., I. E. Álvarez, F. J. Sánchez R., G. Castillo T., P. B. Noyola, M. A. García G. are with Departamento de Electrónica, Universidad Autónoma Metropolitana, Av. San Pablo No. 180 Col Reynosa Tamaulipas, Delegación Azcapotzalco C.P. 02200 México D, F., MEXICO D. F., (e-mails: david.maxinez@yahoo.com.mx, fra@correo.azc.uam.mx, smashblue_brothers9@hotmail.com, fjsr@correo.azc.uam.mx, gct@correo.azc.uam.mx,bpn29@hotmail.com, ggma@correo.azc.uam.mx).

However there are determining factors in the growth and independence technology countries of Latin America and those considered to be of first world that directly influence not only in the educational aspect but also in the economic [4], this last, it is one of the factors with greater problem, the cost of educational equipment, he is tall, occasionally inaccessible to students or schools; Whereas systems of robotics education in its different platforms provide service to two or three students maximum "benefit" here the relevance and importance of use and take advantage of the infrastructure provided by the use of information technologies and communication.

ICT and the efficient use of the teaching techniques, have not only encouraged learning in an entertaining and interactive way, but they have led to a viable alternative that keeps at the forefront of virtual way to regions or students with limited resources [1].

"Learn-doing" on the other hand is technical didactics most recurrently used in the current constructivist, the reason, "develops a rate of retention of knowledge of approximately 80 students" [2], the strategy considers the cognitive, social and emotional aspects of the human being, i.e. the student building through a logical inference based on their individual learning and experience in practices it [3].

## II. Formulation of the Problem

### *A. Introduction*

Create an interactive program for students of level: pre-school, primary and secondary to allow the construction of the various morphologies of robots. That also incorporates the development in a virtual setting and implementation, to stimulate not only his apprenticeship, but skills: concentration, capacity for analysis and synthesis, imagination, computational ability and teamwork.

### *B. General features and specifications*

"Software engineering" planning considers that the application must be able to install on a personal computer with minimum requirements in hardware-software, according to the basic equipment existing in public and private schools and complying with the following general specifications.

- Be fully interactive and handled through a mouse.
- Count on various multimedia elements of auditory and visual support for the proper understanding of instructions.
- Enable the integration of new designs that will awaken your curiosity and imagination, avoiding boredom.

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- Have a stopwatch to measure the time of development and construction of each prototype, in order to assess their performance and ability to concentrate.

In particular the software must stimulate the development of the skills mentioned above:

- Concentration: Ability to observe and build a certain type of robot in a given time.
- Capacity for analysis and synthesis: used to discern and to establish a strategy, a pattern of construction or a particular morphology, according to the stage of implementation.
- Imagination: Developing new ideas for the construction of robots using the tools available in the base software.
- Computational ability: Allow the mobility within the application through the use of activating buttons with ability to select, move, close, open, reduce and exchange information in a graphic environment.
- Work in team. Develop an individual idea within a group scheme to form a global project in conjunction with other students "the professor in its role as facilitator in a project-based learning environment ABP" [9].

## III. Solution of the Problem

A conceptual analysis of the project took place to determine: the software to use, compatibility and Computational platform that supports the application.

### *A. Reverse engineering*

To develop and shape each of physical parts in a virtual environment, we use the design tools from Autodesk 6, tool used by artists and designers for the generation of games, Visual effects and graphics in motion, in 2 or 3 dimensions, is our project, they specifically use Autodesk 3ds Max, Figure 3.

In essence, reverse engineering is based on the fact of developing a new idea or application from an existing product, usually seeking to determine that this fact or as built [5].

In our application, the idea was to develop an ABP activity, providing a teaching team of construction age children; pre-school, primary and secondary, asking them to build any morphology robots of type: Android, Zoomorphic, mobile, Poliarticulated and hybrid.

- *Android:* Robot with human appearance.
- *Zoomorphic:* Robot with animal appearance.
- *Mobile:* Robot with a capacity of displacement.
- *Ploiarticulated:* Robot capable of movement in his limbs for pick up or move objects.
- *Hybrid:* Robot with mixture of the previous morphologies.
- *Android:* Head
- *Mobile:* Platform based on wheels.
- *Poliarticulated:* arms.

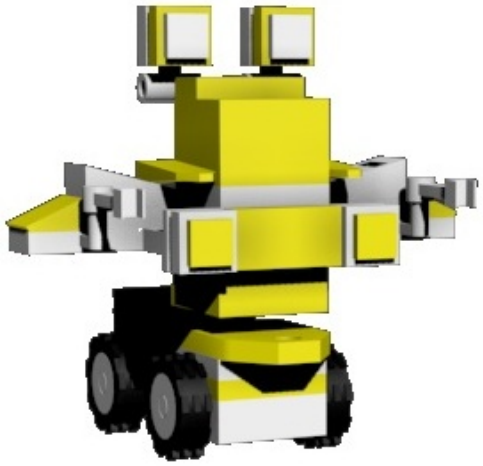


Fig. 1 Morphology robot hybrid

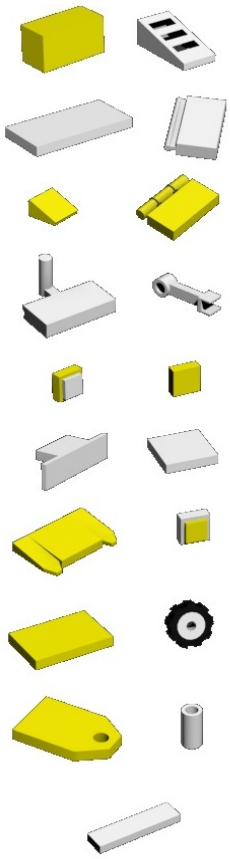


Fig. 2 Catalogue pieces

After its construction the physical prototype is was unraveling step by step until you get each of the individual units of the project.

Total designs carried out by students "creativity and imagination" gave the pattern for generates a catalog of parts, Fig. 2.

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*B. Modeling*

To develop and shape each of physical parts in a virtual environment, we use the design tools from Autodesk 6, tool used by artists and designers for the generation of games, Visual effects and graphics in motion, in 2 or 3 dimensions, is our project, they specifically use Autodesk 3ds Max, Fig. 3.

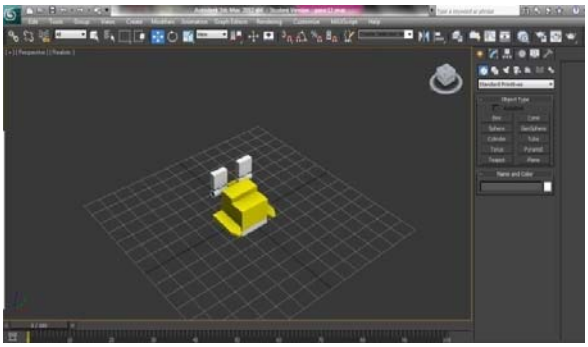


Fig. 3 Individual modeling through Autodesk 3ds Max

At the end of the modeled process, started the sequence to rebuild the original prototype, through the concept of reverse engineering "decomposition and restructuring", this was done piece to piece, with the object of general Assembly manual. As shown in Fig. 4.

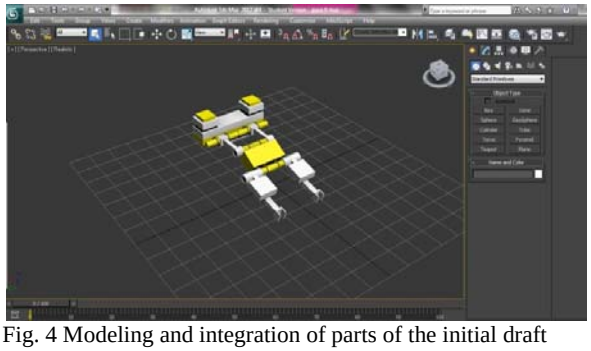


Fig. 4 Modeling and integration of parts of the initial draft

The successive integration of each individual piece gave rise to the recreation of the physical prototype in a virtual environment, Fig 5. This new perspective, have the image on the computer screen, provides certain advantages: recolor, observe its look from various angles, rotate, move, close-ups and delve into details.



Fig. 5 Virtual format obtained by reverse engineering

*C. Integration*

The interactive part includes two aspects; the construction of the robot and the manipulation of the structure with the object that the student observe its behavior in a virtual scenario according to their field of application.

- *Design platform:* The software runs in the Adobe Flash Player platform which is supported by the majority of current computer systems.
- *Programming language:* Action Script 1.0 is the tool of object oriented programming that allows great functionality and management in the events generated by the user.
- *Multimedia tool:* Flash Professional tool that allows the incorporation of bitmap and the League with sound files, for creating high-performance interfaces.

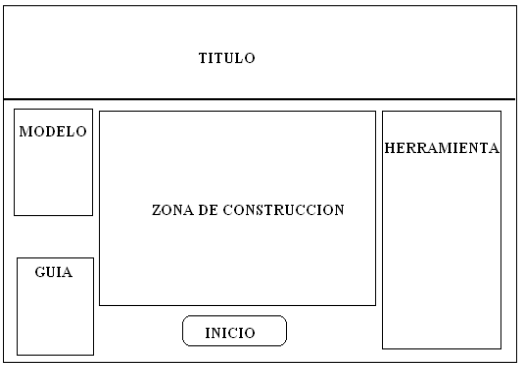



Fig. 6 User's screen

*D. Screen design*

In Fig. 6, as you can see, user's screen is bounded by the following areas: model, guide, area construction, tool, the description of each area is specified in the following way:

- *Title:* Displays the corporate data of the institution.
- *Tool:* In this area are the catalogs of parts that can be used for the construction of a prototype.
- *Construction area:* It is her area available to build the prototype, the student selects the available in your block of tools piece and her move to their area of construction through the mouse.
- *Model:* Within this area is the different morphologies of the robots; Mobile, Android, hybrid, Zoomorphic and Poliarticulated, the student selects a type and later one of the already preset models to start with its construction in the corresponding area.
- *Guide:* In this area it is step by step graphic the beginning and end of the project, students used this guide to the development and Assembly of your robot.

Fig. 7 shows the aspect of the application. The characterization of this presentation, considers the teacher as a facilitator guide within a scenario of learning based on ABP projects [7]. The teacher provides the participation of each Member of the Group: Member of the team, moderator, Secretary or tutor; considering that individual participation can be the basis for establishing a group project, which includes the exchange of ideas and allow the closure of the topic.




Fig. 7 Presentation of the project

At the end of the Assembly of the prototype, the application takes you immediately to the window of virtual and interactive scenarios [8].

*E. Screen scenarios*

The screen of scenarios is the means used by the student to manipulate its structure "model" in a virtual environment, which is shown in Fig. 8.

Within this block, the following sections have predisposed: virtual stage, stage, model and control.

- *Virtual scenario:* shows the scene where the robot for subsequent handling, inserting Fig. 9.
- *Scenario:* Within this area the student can choose various virtual environments designed to recreate the environment of implementing the structure.
- *Model:* Within this area shows the prototype shows.
- *Control:* In this area are available for handling the robot control.
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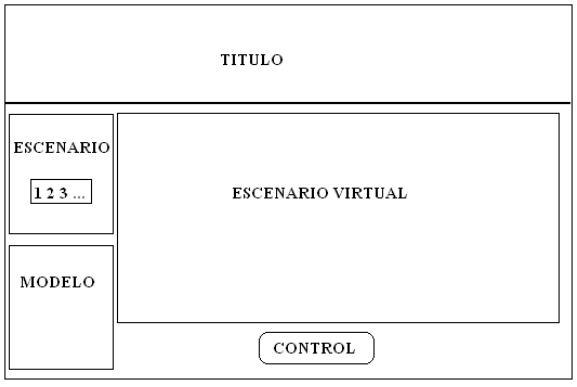



Fig. 8 Scenario structure




Fig. 9 Screen virtual scene

The basic elements that provide interactivity on the agenda are the activation buttons, which are shown in Fig 10. ActionScript allows you to create objects whose functionality can be manipulated to execute procedures defined by the programmer. In this case, each button is set to perform jumps under the program which can bring the user to the following application blocks.

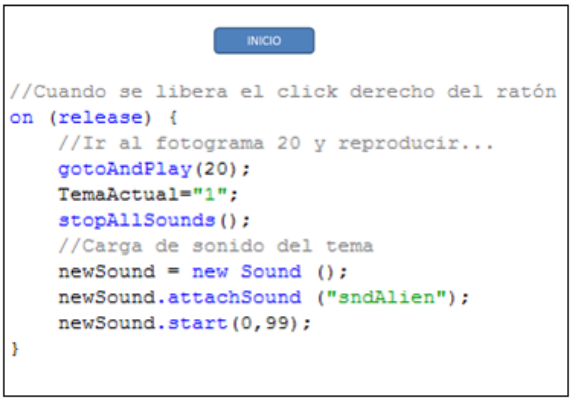



Fig. 10 Code for activation buttons

On-screen scenarios we have added elements multimedia and atmosphere of the game through animations scheduled in the time line, by specifying them its duration through the use of frames. The integration of sounds in the interface enhances the user experience, generates a pleasant atmosphere, files are loaded in MP3 format and added to libraries in the program to be played automatically on your running routine execution. This is shown in Figure 11.

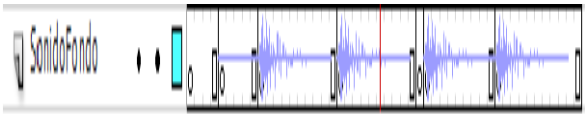



Fig. 11 Phonograms

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## IV. Conclusions

The development of this work fulfills the objectives for which it was designed, and explores new niches of opportunity at the corporate level "Robotics educational virtual".

It allowed us to determine that the current constructivist learning method and didactic technique ABP [9] may correlate to awaken the interest of the students in topics, where experience and social environment can be important factor in the acquisition of knowledge.

The evaluation and implementation of this project place through a student sample of several days at school levels from primary and secondary schools, highlighting the ingenuity and imagination in the development of new prototypes.

## References

[1] Gómez Flores, S.G. (2004). "El profesor ante las nuevas tecnologías de información y comunicación". Revista Digital de Educación y Nuevas Tecnologías. Número 28. Año V, Disponible en internet en: http://contexto-educativo.com.ar/2003/4/nota-05.htm.
[2] Bethel, Maine, Learning Pyramid "average retention rate", USA.
[3] http://www.psicodiagnosis.es/areageneral/desarrollodelainteligenciasegunjpiaget/index.php.
[4] G. Maxinez David, Sánchez Rangel Francisco Javier, Castillo Tapia Guillermo, García Galván Ma. Antonieta. "Robótica Educativa, Tecnologías de la Información y Educación", CICOM2012, Chilpancingo Guerrero México, 2012.
[5] García A., Jiménez E., Ontiveros S., Luna G., Reyes L., Martinez V., Delfín J., Arellano L., "On the Reverse Engineering and Engineering Education in General. Proceedings" of the XI International on Engineering and Technology Education. March, 2010, Ilhéus, Bahia, Brazil, 2009.
[6] http://usa.autodesk.com/3ds-max/
[7] Harwell S., "Project-based learning", In W.E. Blank & S. Harwell (Eds), Promising practices for connecting high school to-the real world, 1997, pp.23-28.
[8] G. Maxinez David, García Galván Ma. Antonieta, Sánchez Rangel F.J., Chávez Cuayahuitl E., Ferreyra Ramírez A., "Interactive Scenario Development", Recent Research in Mathematical Methods in Electrical Engineering and Computer Science. Angers France, November 2011, pp 35-39.
[9] G Maxinez David, Soto Donjuán Kenia Rubí, David Velázquez Rosado Luis. "Física educativa mediante ABP". Tecnologías de la Información y Educación CICOM2012, Chilpancingo Guerrero México, 2012.

**David G Maxinez** was born in Mexico City on 24 august 1959. Get their studies of mechanical engineer in the electrician Universidad Nacional Autónoma de Mexico. Won the degree of master of engineering with specialization in electronic within the division of graduate studies of the Faculty of Engineering of the UNAM. Within the Instituto Tecnológico y Estudios Superiores de Monterrey extended diploma in teaching skills and the graduate diploma in microelectronics. It is currently candidate for the Metropolitan Autonomous University of Mexico city.Within their work has been the: Head of maintenance and Technical Secretary of the career of Computer Engineering in the UNAM FES Aragón, Head of the Department of Electronics of the Faculty of Engineering of the UNAM, Head of group laboratories Sigma Commodore, Head of the Department of innovation and technological development of the company Robótica 3D. Now is the president and the creator of the concept Exporobótica, Expociencia, Exporobots and events of public understanding of science and technology of education held at the national level in various states of the Republic of Mexico. He is the author of the book VHDL the art of programming digital systems 2002, edited by Group Patria Cultural, S. A de C. V, is currently at the 8th überarbeitung ISBN 970-24 -0259-X. Mexico D. F. Within their latest work emphasizes "Interactive Scenarios Development" **.**Conf .en Recent Researches in Mathematical Methodos in Electrical Engineering and Computer Science. France November pp 35-39, ISBN 978-1 61804-051-0..." integration in a FPGA on the control of a mobile robot" Conf. , 2Do. International Congress of Computing, Chilpancingo Guerrero Mexico, págs. 51-55, 2012, ISBN 978-607 -7760-62-7. He has been awarded by the department of science and technology of the federal district in Mexico city, winner of the second place in the development of educational materials digital resources for the DF. It is cst adviser robotics of the Universidad Nacional Autónoma de México y de la Universidad Autónoma Metropolitana.

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