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Teaching Mechatronics with Real Projects and Integral Vision

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ABSTRACT

The role of Engineers in the society is present in many different ways; we can see its influence in several products, process and services. Many engineers have been educated to solve problems into a variety of sectors, which is allowed the development of companies, corporatives and nations too. It is a fact, that in the shadow of each product there are production lines, and technology that engineers design to make possible that products, from the concept to the market. Special mention should be given to a multidisciplinary approach called "Mechatronics". Engineers on Mechatronics are educated to apply methods and technology with integral point of view by using the mechanics engineering, electronics engineering and information systems. An engineer with integral vision and expertise will be in very good conditions to develop original solutions with a good perspective to make new business.

Traditional Teaching of Engineering

The traditional engineering academics programs essentially are based to teach engineering under the concept to develop a sequential process. During the first years, students learn about mathematics, physics, electricity, electronics and some topics related with the specific engineering program. In next years, some courses about design, manufacture or production are the base of its education. At the end, topics about engineering projects, testing, cost or technology are essentials for the students to give them abilities for their future work. The result is a professional with a limited view of needs, technology and solutions in interdisciplinary terms[1].

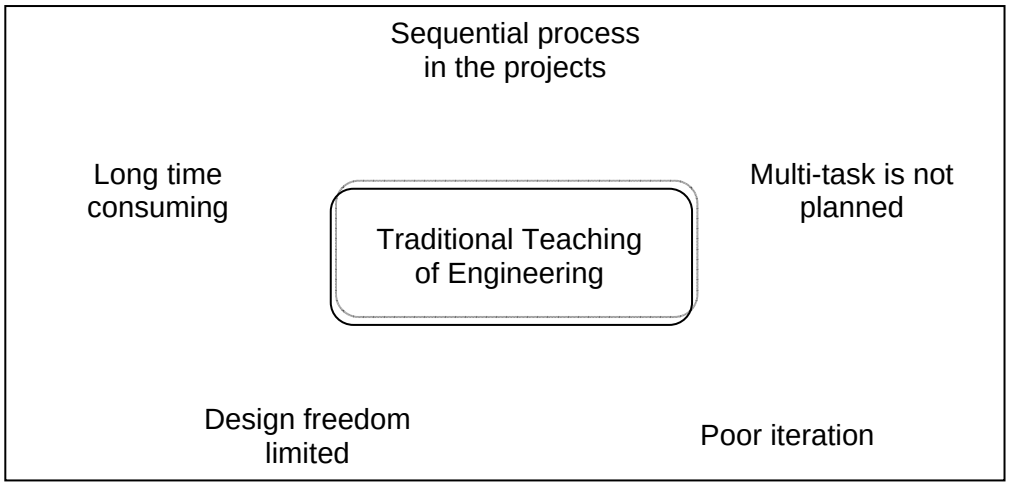

Figure 1. Some problems in traditional teaching of engineering

[1] "Olin Collegue Back Traditional Engineering Education", Ann Greeneval, Boston Business Journal, January 24, 2003.

In the last decade, some University has reported changes in the engineering education process. Some of these changes include experimentation, academic and industrial research projects, participation in competences, and others. The objective was to improve student's education by the idea to put hands-on in real projects. [2, 3, 4]

Proposing Changes in Engineering Academic Program

The increasing impact of technology and the dynamic in the global market shows a great opportunity to incorporate new changes in academic engineering programs. Synergetic interactions between various engineering disciplines are required to meet the technical and technological challenges of the future. In this context special consideration should be given to a multidisciplinary approach called "mechatronics". In its fundamental form mechatronics provides a synergetic combination of traditional engineering disciplines such as mechanics, electronics and computer science.[5] By other side, recently an integral vision education to provide business abilities in engineering students is showing good results in short time. Students and professors are creating potential new business with the sense of the market requirement and the application of high technology. Few Universities in the world have adopted this new strategy in the education process. [6, 7]

The renovation of engineering academic program in the Universidad Anáhuac México Sur is going on. The first academic program on mechatronics engineering was done by the Universidad Anáhuac México Sur in 1992. At the time, there are around 80 educative institutions that offer studies on mechatronics in Mexico [8]. As a result of the analysis of our story and the projection as an educative institution leader in mechatronics education in Latin-American countries, we are planning changes in the actual academic program study for Engineering of Mechatronics. Figure 2 shows the new conceptual teaching model that we will implant for the next years. Basically, there are three knowledge areas that interact between them to complement the actual academic program that permits to develop an integral vision of engineering.

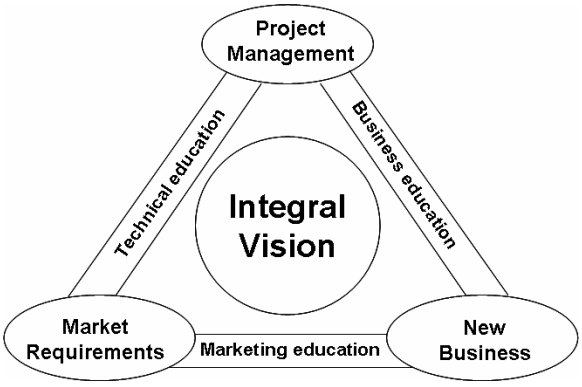

Figure 2. New conceptual teaching model for engineering of mechatronics at the Universidad Anáhuac México Sur.

[2] "Introducing flexibility in traditional engineering education by providing dedicated on-line experimentation and tutoring resources", Sylvie Ursulet and Denis Gillet, International Conference on Engineering Education 2002.
[3] "Hands-On Laboratory Experiments in Flexible and Distance Learning", Gillet, D., Latchman, H.A., Salzmann, Ch. and Crisalle, O.D., , Journal of Engineering Education, 2001.
[4] "Welding in the Century of Information Technology", Drews, P., and Starke, G , Welding World. Vol. 34, 1994.
[5] Mecha … what?, by Richard Comerford, IEEE Spectrum, August 1994.
[6] "Leading Edge of Cybernics: Robot Suit HAL", Sankai,Y. SICE-ICASE, 2006. International Joint Conference Volume , Issue , 2006.
[7] "MIT Media Laboratory. inventing a better future", The Media Lab at a Glance**,** http://www.media.mit.edu , 2008.
[8] "Diagnóstico y prospective de la mecatrónica en México", S. Veruette, Secretaría de Economía – México, 2008

Teaching Mechatronics with Real Projects

The vision to teach engineering in different disciplines by doing real projects is not a new idea; there are several Universities that have been developing this didactic method with good results [9], [10]. Mechatronics Engineering presents excellent conditions to facilitate in the students abilities to design, control, manufacture and business of mechatronical machines. Robots are essential examples as a mechatronical machines is, but also many industrial processes and services can be included as mechatronical products. In the last five years in mechatronics academic program at Anahuac University, several approaches have been employed to incorporate real world projects into engineering courses. We have noted that students are not fully prepared to enter the real world after graduation. Team work, interaction with other disciplines, international stays in companies or Universities are only other strategies that we consider fundamentals in the Faculty of Engineering. Real world projects introduce in the students to the formulation problems, the design of a solution strategy and also commercialization vision to generate different benefits.

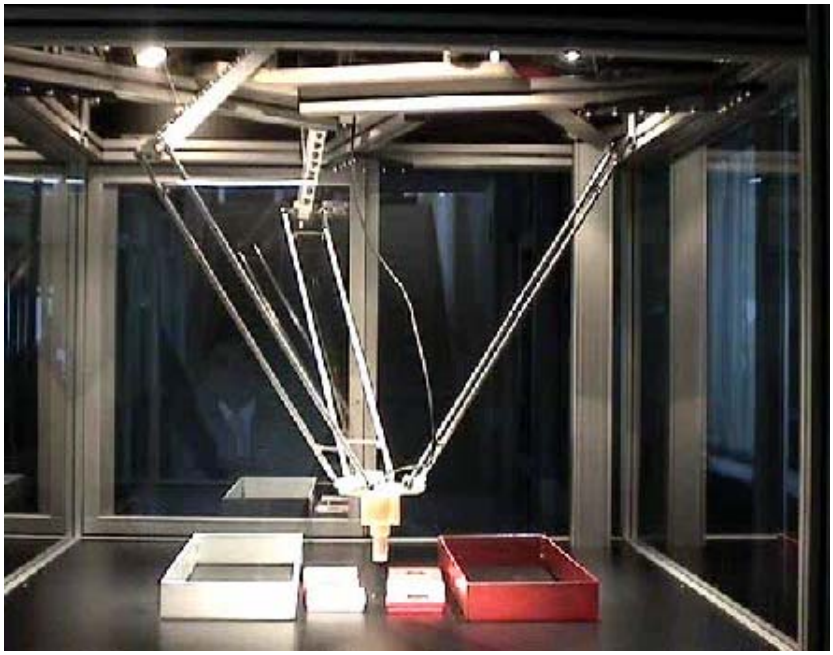

Figure 3. Parallel manipulator robot made from students in 6° semester of mechatronics engineering program.

Figure 3 shows a parallel manipulator robot, that it was doing from concept to real test behavior[11]. The actual project is also under development to design a new manipulator with integrated vision systems to be used in industrial application of candies manipulation.

[9] "The Future of Engineering Education: II. Teaching Methods that Work", Felder, R.M., D.R. Woods, J.E. Stice, and A. Rugarcia, Chemical Engineering Education. 2000.

[10] "Incorporating a Real World Project into an Engineering Course", Eric Asa, 9th International Conference on Engineering Education, 2006.

[11] "Diseño y Control de un Robot Paralelo", Meneses J. X., Méndez C. M. y Cortés B. E., 6to. Congreso Nacional de Mecatrónica, México, 2007.

According with data from ABB, a global leader company in power and automation technologies, one of its customers from the industrial food production sector reports a total sales in 2004 are about 50 million euro[12]. This company applies several automation machines in its plants, include robot manipulator. Finally, they report that sales have been increasing 10 percent annually in recent years. We consider interesting the market for this kind of robot, and the student that were involved in the project are projecting a commercial production and potential business to apply the manipulator.

Mechatronics Methodology in the Projects

As an essential knowledge of the plan to develop a mechatronical machine, a method developed in last years was used to reduce time and facilitate the interaction between the students and professors. This mechatronical method to develop industrial machines has been used for industrial projects and academic research projects [13,14, 15]. However, it is important to mention that industrial projects are quite different from academic projects. Industrial projects require a quick and dynamic interaction oriented to reduce the project time and get the final results into a reasonable cost. Figure 4 shows the main components of the method. After organize the work to do, students and professors form several teams to work in different areas, but also they interact between each other. In a research project to develop a mobile robot, three different teams were formed: a) Design and simulation team, b) Manufacture team, c) Control and test team.

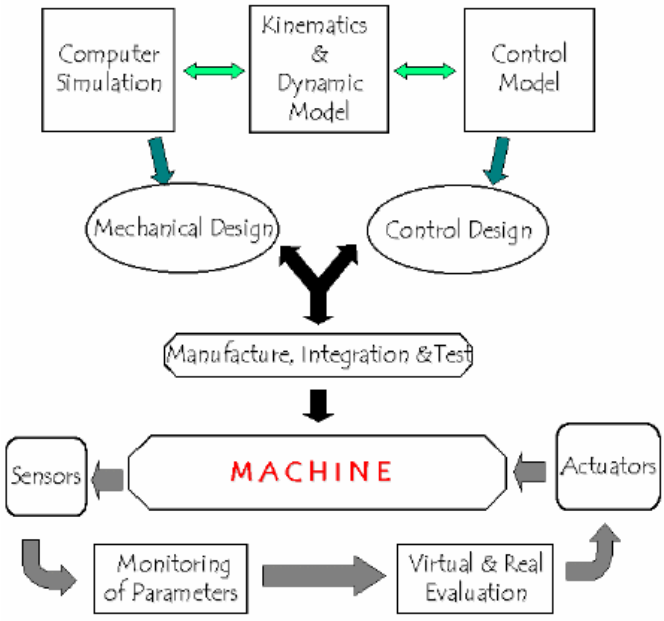

Figure 4. Mechatronics methodology diagram to do projects

[12] "Robot-wrapped birthday package", Claudia Flisi, PACKING ROBOTICS, a magazine of ABB, November, 2004.
[13] "Diseño de un Robot Industrial para Aplicaciones de Limpieza en Subestaciones Eléctricas", Vargas E., Reynoso G., Villarreal L, Mier R., 3er. Congreso Mexicano de Robótica, México, 2001.
[14] "Free Locomotion for Six Legged Robot", Gorrostieta E., y Vargas E. WSEAS Transaction on Computers, 2004.
[15] "Mechatronics Design of an Automatic Machine To Manipulate Sheet of Cardboard", Vargas E, Rodriguez W., International Congress on Mechatronics and Robotics, IEEE Industrial Electronics Society, European Center for Mechatronics, Germany, 2004.

The method consists; first of all, in generate the mathematical models which describe the behavior of the mechanical structure of the robot. The kinematics model is well defined to evaluate by simulation the parameters for each system: mechanism, wheels and terrain. After to validate the kinematics model by analysis the results of simulation, we consider a first approximation of the real behavior and the virtual design. The next step of this methodology consists to construct the mechanical design of the systems. In this part, it is assumed that also control design can be made in parallel and with interaction of teams-work involved. By this way the fundamental elements are defined and others can be bought. Usually, during the manufacture process the design parameters are changed, some of them depend of the material properties, and other factors for the final dimension in the elements. Any case, it is recommended to improve the physical models with these changes and simulate again the new characteristics that will present the designs. As well known, there are also changes when the systems are integrated. New modifications were implemented to pass the production tests. After to get the robot prototype, next step is evaluate the real robot comparing with the mathematics models. The main idea at the end of the methodology is to modify and improve the models used to design the mobile robot, and get a better understand of the real behavior of the systems.

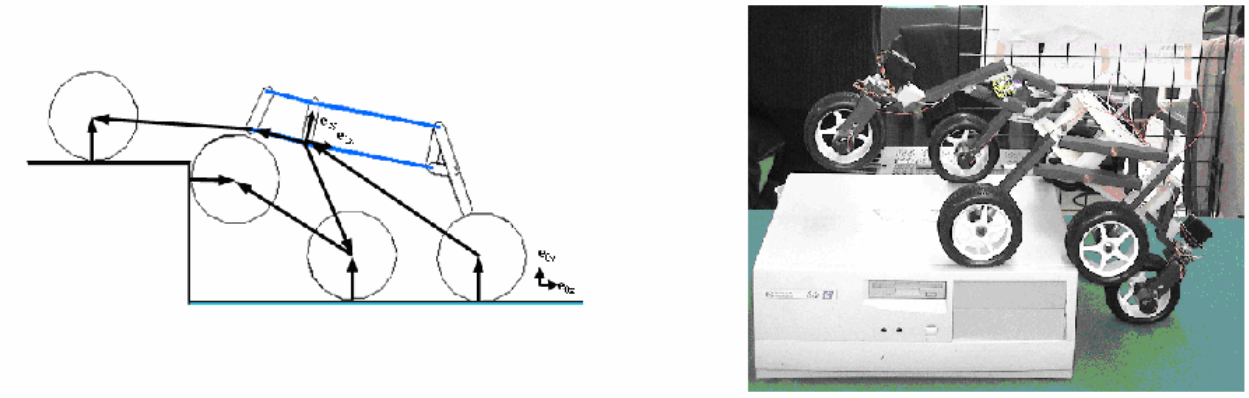

Figure 5. Mobile robot developed in the Universidad Anáhuac

The knowledge and application of this methodology is a powerful way to plan specialized engineering activities involved in the research project. The effective time dedicated to the project can be considerable reduced by a good organization, and definition of the results.

Why a Business Vision in the Engineering Mechatronics Education?

The traditional methods in the teaching of mechatronics engineering are well oriented to get technical abilities and practical expertise in the best of cases. There are many schools and faculties of engineering in the world that teach mechatronics with a wide international recognition. But also, wonderful opportunities exist to implement new educative strategies according to the requirements of the society, being used the opportunity that offers the new technologies. According with this, some knowledge areas in the academic engineering program are proposed to get a market vision to the engineering students. By this way, the engineering student not only will be prepared to solve engineering problems successfully, but also, to visualize new opportunities of business with support of technology.

Taking into account that the actual market is global, and as the education in engineering prepares the students to work in any country. The following areas of the knowledge are proposed to obtain a complementary formation of business:

Market requirements
Development of production
Creation of business
Administration management
Supply chain
Ethics and human values
Finance of projects

There are few engineering academic programs in the world with this vision. According with the Engineering Route to Business Program from the University of Texas, the combination of engineering and business culminates in students leaving the program well prepared for success in managing highly technical business environments[16]. The Mechatronics and Management Program, in the McMaster University, has have designed an innovative world class mechatronics program that offers a balance of mechanical, electrical and software content with a focus on embedded systems design, managerial finance, production/operation management and applied marketing[17]. There are also interesting programs where students from engineering and business schools work together to get better education and future perspectives. The engineering and business schools at Imperial College London in England are cooperating in program called EnVision 2010, which brings together students from two groups to help train them better for the world they will enter after school[18]. On the other hand, with regard to the experience of the School of Business of the Universidad Anáhuac México Sur, a high percentage of their students in the Masters of Business Administration (MBA) are engineers. This situation confirms the necessity of the market in having people specialized in engineering and business.

Prospective and Future

Doing a real world project with students and the guide from professors in different disciplines has been increasing the academic level, and also the interest about technology and its potential application to make new business. The multidisciplinary teamwork has been a good way to enrich the education and look for new strategies to respond to the market needs. During the project execution students and professors has showed a better relationship, not only in the professional sense, but also in human aspects. These human aspects are essential to plan together a future new business. At the time, the business education is not formal in the academic program, but is planed to be implemented next year. The real world projects done in the last years have showed the natural interaction between engineering and business. The idea is not new, but it is beginning to change the form to educate our futures engineers and leadership on businesses.

[16] http://www.mccombs.utexas.edu/udean/advising/degree_info/erb.asp
[17] http://www.cas.mcmaster.ca/cas/mechatronics/
[18] http://www3.imperial.ac.uk/envision