Are we really doing Mechatronics?

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Abstract

This paper shows the current existence of a limited conception of Mechatronics. It usually referred to as a simple combination of disciplines. This notion it is explained by historical and evolutionary factors. In Mexico and even in the world is necessary to emphasize the benefits of innovation that would bring the proper use of the synergies of technologies and disciplines involved in Mechatronics. The ideal setting for growing synergies is the solution of the social needs presented in engineering projects.

Introduction

Mechatronics is a philosophy[1] (Grimheden & Hanson, 2005) design (Roberts, 2010) of products and production processes that are currently in the process of consolidation. It has evolved from a purely practical approach to those of scientific and educational research. Currently prevails, little effort to achieve synergy between disciplines within it. It should perhaps, in education, the paradox between choosing the path of specialization in disciplinary knowledge (Grimheden & Hanson, 2005) or to choose the path of cultivating the ability to integrate this knowledge (Acar, 2010). In the field of industry, perhaps, to ignorance of the benefits of synergy itself. It is therefore relevant task of finding synergies in the design of Mechatronics systems.

Origin of Mechatronics

Generally it is accepted that the Mechatronics was born as a practical necessity in the industry, since the term was coined in the 1970s by Tetsuro Mori Company Yaskawa Electric Co., Japan (Robles Aquino, Corona Ramirez Fernandez Nava, & Raven Pinto, 2010). This is true, assuming that philosophy originated in the time when the term was coined. Otherwise, it has set that it was the result of some evolutionary engineering, as suggested by Figure 1, (Vantsevich, 2010).

[1] Here, "Phylosophy" is used in its inception of the particular understanding system of life (the engineering) and everything related to it (Diccionario de la lengua española, 2005).

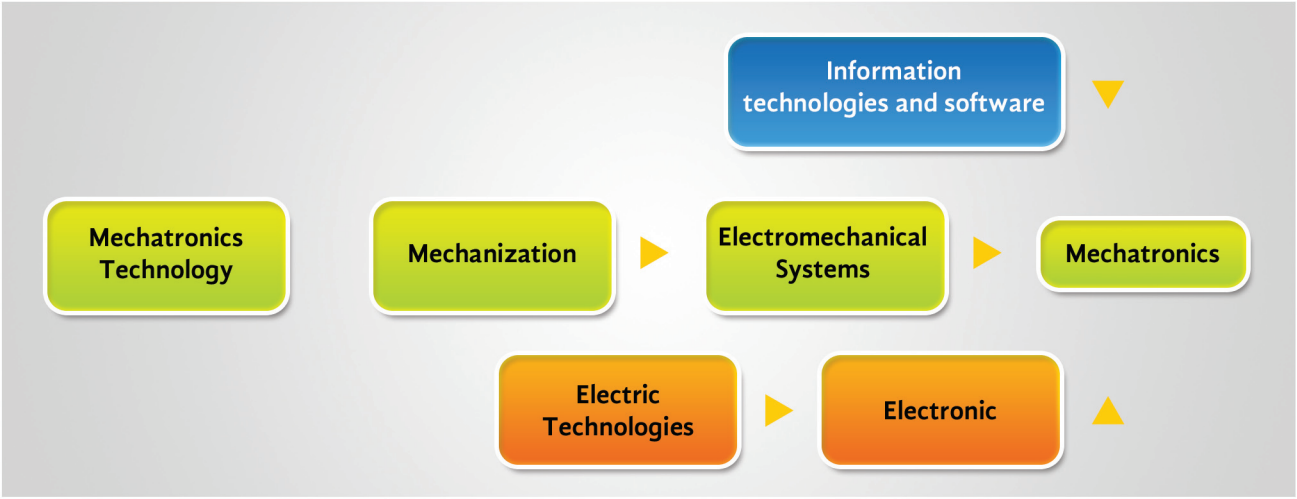

Figure 1: Mechatronics evolutionary technological appearance

In this illustration can be interpreted that the advent of this engineering philosophy was "natural" given the appearance and development of technologies that comprise it. That is, by the appearance of machining techniques and electrical, and mechanical engineering based, emerged the field of electromechanical systems. This trend continued in a similar way to the birth of Mechatronics.

The path that has led to the current point Mechatronics also can be tracked through its definitions over time. At its inception, with Tetsuro Mori, perhaps it was only the union of mechanics and electronics, as it can guess from its name components "mechanics" and "electronics". You can see that the first definitions of philosophy here occupies treatment consisted of her "only as an interdisciplinary subject," in the best case, or as a "union between the mechanical and electrical engineering, control theory and computer science, all wrapped in a single area of engineering "(Grimheden & Hanson, 2005).

Common understanding of Mechatronics

The concept outlined in the previous paragraph is still rooted in some universities in Mexico. For example, the concept as "the mechanical-electronic engineering specialized in control, instrumentation and industrial automation". See Figure 2 (ITESM-CEM, 2004).

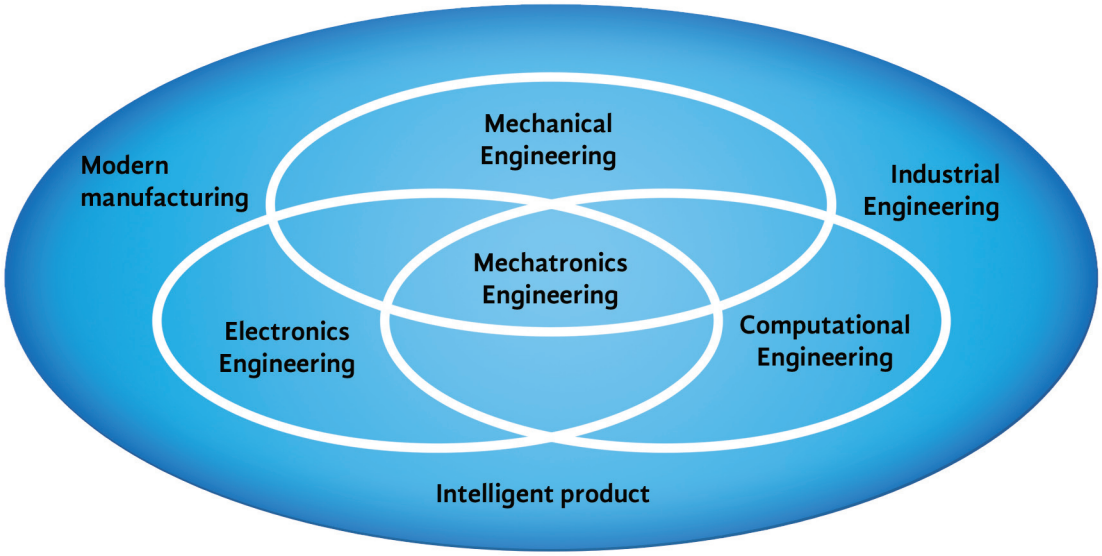

Figure 2 Concept of Mechatronics of a Mexican institution

i When Mechatronics is understood in these terms, the concern focuses on academic mastery of a wide number of topics. This is reflected in textbooks that focus their attention on the exhibition, without detail, various issues (Bolton, 2010). Even the titles of certain books (Bolton, 2010), (Bradley, 1991) indicate a poor understanding of the philosophy in question. Mechatronics hint that is only the addition of electronic consumer products or electronic control to mechanical and electrical systems. The union of disciplines implies instructing personnel or students with a variety of expertise and different engineering topics.

It is not uncommon to find students in advanced semesters of Unidad Profesional Interdisciplinaria de Ingeniería y Tecnologías Avanzadas, Instituto Politécnico Nacional, exclaiming: "Oh, so Mechatronics is Automation". Saying this implies an oversimplification of the philosophy in here explained that evidences a perfectible and training in it. This may be because some educational programs do not take responsibility for teaching Mechatronics, but only focus on teaching a variety of subjects. Thus the responsibility for the Mechatronics relies in the student, who did not even know they have this responsibility. Even engineering graduates say the main advantage of Mechatronics is the dialogic ability between engineering converging on it (www.facebook.com/dario.cuervopinto/posts/184323054934994). This assertion is supported by experts, they say that the contribution of Mechatronics should not be overestimated, even though it is recognized the

need for disciplinary specialists to communicate their ideas of having a "translator" between them. It is said the challenge of Mechatronics course designers it is to establish a balance between depth knowledge and the ability to act in integrating activities in a wide range of environments (Vantsevich, 2010). Other authors argue that students should be deep enough knowledge in at least one area of technology in order to make effective contributions in that area, while ensuring a breadth of knowledge necessary to give credibility to interact with other specialists (Bradley & Russell, Mechatronics in Action, 2010).

Internationally, we have examples such as the Master of Science in Mechatronics at KTH: "Generally, students are enrolled in programs of mechanical engineering, vehicle engineering and industrial management. Course culminates with a completely organized by project and problem-based learning. Students are asked to applying their knowledge in a technology project in collaboration with industry. This will teach students the Mechatronics is a philosophy and that can hardly be taught in theory, but it has to be experienced "(Grimheden & Hanson, 2005). Note that the concept of teaching is highly practical.

Another example is the International Master of Science in Mechatronics Systems Engineering at Lawrence Technological University, which expects students

> i. "Learn the mechanical principles in the design of Mechatronics systems,
> ii. develop strong math skills and application of analytical dynamics and adaptive Mechatronics systems,
> iii. provide expertise in the areas of logic design of Mechatronics systems, development of intelligent control algorithms and robust, classic and modern, and design of mechanical systems in conjunction with control systems,
> iv. develop analytical skills in optimizing Mechatronics systems,
> v. learn design principles and are skilled in implementing control algorithms to hardware. "

Note that it is privileged variety of topics such notion of Mechatronics education. This degree is taught collaboratively by the departments of Mathematics and Computer Science, Electrical Engineering and Computer, and Mechanical Engineering, thereby giving a scientific character to it. By fusing their practices and principles is achieved

> • "Mathematical modeling of dynamic Mechatronics systems and optimization,
> • Logic control algorithms with robust and intelligent

• Mechanical systems with electrical and electronic hardware,
• Computer programs for the implementation of control algorithms with robust logical and intelligent,
• Programmable logic devices. "

On the other hand, in industry, not many companies are willing to accept Mechatronics graduates as an important contribution to the traditional titles (Vantsevich, 2010).

Modern notion of Mechatronics

In recent times it has been postulated that the main theme is the mutual benefit between disciplines, ie "the synergy of precision mechanical engineering, electronic control and systems thinking in product design and manufacturing processes" (Grimheden & Hanson, 2005). The radical difference in this approach is the modern term "synergy", it is defined as the "union of several forces, causes, etc.., for greater effectiveness" (Dictionary of the Spanish Language, 2005), or as the "action of two or more causes whose effect is greater than the sum of the individual effects" (Royal Spanish Academy). It follows that the application of the Mechatronics should focus efforts on achieving synergies between disciplines from the time of design. The small change is not involved and, in the case of the union of disciplines, concerns only the subsystems disciplinary interfaces, and in the case of synergy, the eventual rise of new technology (Grimheden & Hanson, 2005). The knowledge society "requires innovations and changes in traditional forms of training, production, disclosure and access to public and private services" (Ministry of Education, Culture and Sport, 2003).

Achieving synergy

Bradley & Russell, (Mechatronics in Action, 2010) while recognizing the importance of synergy, not clearly address. It is sometimes proposed as a means to achieve a concurrent design approach. A concurrent engineering cycle is the first stage of requirements definition. In a second live stage conceptual design, design for manufacturing, quality, design, testing, marketing, industrial design and interface design. A third crystallization stage is composed of design, service and support, and manufacturing processes. The fourth stage is the manufacturing and, finally, the fifth, the finished product. All with possibility of feedback, in either direction (Bradley & Russell, Mechatronics in Action, 2010). Note that at no point discussing interdisciplinary or synergy. More successful, it is stated that the essence of Mechatron-

ics is achieved by considering all disciplines together since the beginning of the design. However it is possible to do this and even then not achieve synergy.

One way we can begin to address the need for synergy is the thematic approach (Grimheden & Hanson, 2005) to either Mechatronics, assimilating that training courses should be directed to the product (Vantsevich, 2010). But historically it has been shown recently, any educational institution has thematic identity.

The identity of a discipline, in academia, is the definition of the same discipline. The identity of the philosophy in question has evolved from a first tier of disciplines separated, going through one multidisciplinary second, then one third cross disciplinary, one curriculum, one organizational fifth and must eventually reach one sixth theme. See illustration 3 (Grimheden & Hanson, 2005). In it, the circles represent disciplines, namely, mechanical, electronics, Control, etc., which are completely separated and are incorporated each other until their borders disappear.

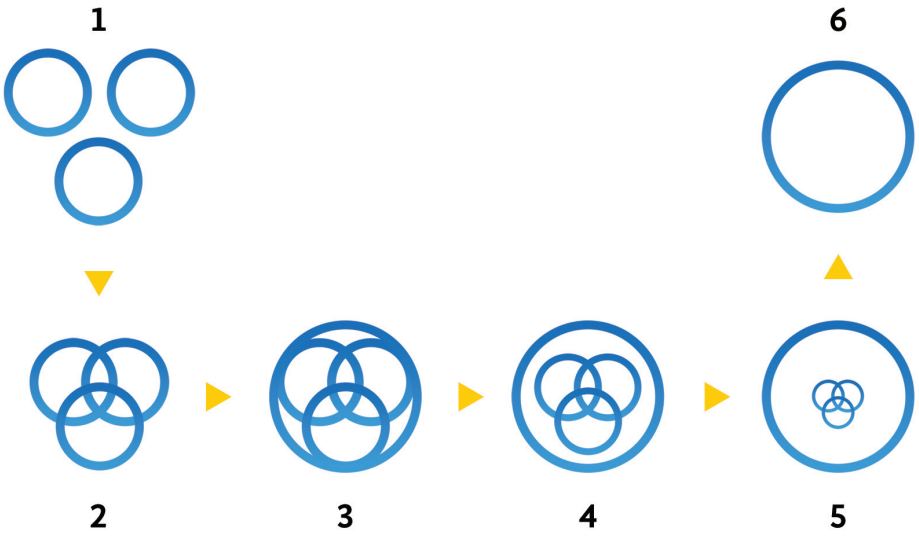

Figure 3: The evolution of Mechatronics as an academic discipline.

In stage 1 if Mechatronics is only because the disciplines that compose it exist and coexist in a haphazard way. In stage 2 students, on its own initiative, take courses in various disciplines only to widen its field of action; However, the educational system still has separate disciplines. In stage 3, is already an interest from the education system

incorporate courses from other disciplines to an original discipline, for example, courses on electrical engineers in mechanical systems.

Such courses are called "mechatronic". Stage 4 is responsible for the creation of an entire curriculum for Mechatronics, same that tries to meet the cross disciplinary courses and who attends, in part, the identity of Mechatronics. Note that disciplinary identity is declining to give rise to the thematic identity. Stage 5 involves an almost complete disappearance of the original disciplines. This is possible thanks to a complete change in the academic organization, for example, with the emergence of departments led by teachers with experience in Mechatronics. This situation requires some time for its realization. The last stage involves treatment of Mechatronics completely as possessor of a thematic identity. Perhaps because not found any institution or organization that has come to the last point, the description of this not addressed clearly in Grimheden & Hanson, (2005). Thus, we see that, even in the literature that complaint the problem of lack of concentration in the synergy, the problem is left open.

Teach a repository of knowledge and various engineering topics does not mean a training in mechatronics, because this, rather than a set of knowledge, is a design philosophy. Learn about topics of mechanics, electronics, electrical and computer, will hardly provide us a particular way (philosophy) to address the problems that we have to solve through the engineering design.

Synergy implies working thematically. By contradiction, you can define the theme as that which does not imply disciplinary divisions, what privileges the synergy between disciplines. It may be considered that the theme will be achieved when and where the Mission of study programmes is the satisfaction of the needs of local industry and the proposal of solutions to global problems. The contribution of Mechatronics Engineer is not alone in its ability to Dialogic, not only in its ability to project management, nor in the proper balance of their theoretical and practical knowledge. Their contribution is where specialists in specific areas not arrive, synergy. Which must satisfy in the daily practice of problem-solving in common situations in the industry.

The real problems are interdisciplinary and complex (Chávez Tortolero). The thematic identity of Mechatronics will be highlighting the synergy, conceptually and operationally, addressing social needs such as projects. Social needs, are inherently complex, interdisciplinary and thematic, can not be solved with a single discipline and its optimal satisfaction crosses by the synergistic effects that gives the Mecha-

tronics. We can finish proposing the following notion: Mechatronics is the philosophy that considers the methodological, optimal and intimate participation according to specific applications of competencies such as electronic, mechanical and control in obtaining products and complex processes for sustainable development since the beginning of the design process.

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