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MODELLING AND SIMULATION IN MECHATRONICS

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Abstract: The paper presents some achievements in complex modelling and simulation in mechatronics, being underlined some characteristics of the mechatronic field together with applications of design principles. Some aspects of the optimized and integrated design having as main part the modelling and simulation of the system are presented. The facilities of the programs used for kinematic and dynamic simulation of multi-body systems are emphasized. Some mechatronic systems are presented as examples of modelling and simulation in MATLAB/Simulink (MS), SolidDynamics (SD) or MotionInventor (MI) programs with accent on robots for micro and nano manipulations of cells, industrial robots, and precessional drives. *Copyright @ 2007 IFAC*

Keywords: Mechatronic systems, design, modelling, simulation, analysis, optimization, micro-nano robots, industrial robots, precessional drives..

1. INTRODUCTION

The concept of mechatronics appeared in Japan 30 years ago, and is a complex concept in a continuous change. It has had the meaning of a synergistic combination of mechanics and electronics, being related to electro-mechanics, but differing in the criteria of design. Therefore, mechatronics is a significant interdisciplinary design trend that involves the application of the latest techniques in precision mechanical engineering, controls theory, computer science, and electronics (Fig. 1) to create and bring fast to the market more functional and adaptable products with precise performances. Some of the key elements of mechatronics are presented in Fig. 2.

The concept of mechatronics has a strong influence not only on the product design and development and the competition on the market, but also on the mechanical engineering education and team leaders or engineering managers.

Thus, the mechatronic products have specific characteristics, including the replacement of many mechanical functions with electronic ones. By applying new controls one expects from a mechanical device to reach new levels of performance. The mechatronic way of thinking and design leads to much greater flexibility and easy redesign or reprogramming.

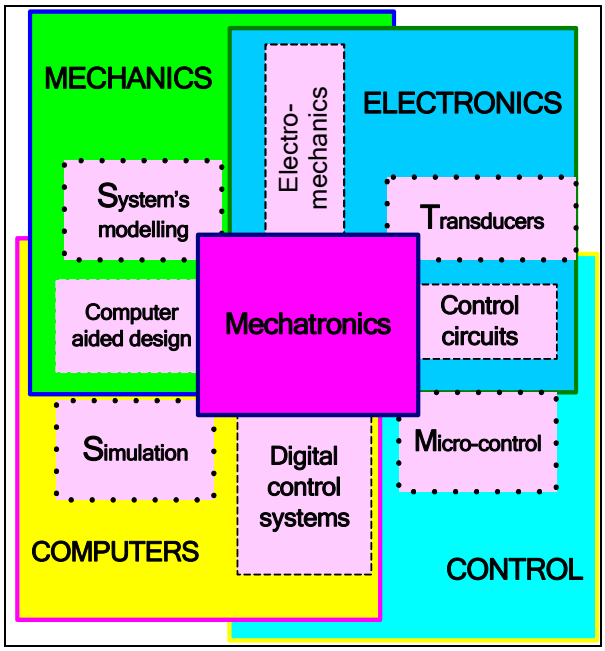

Fig. 1. Fundamental elements of mechatronics

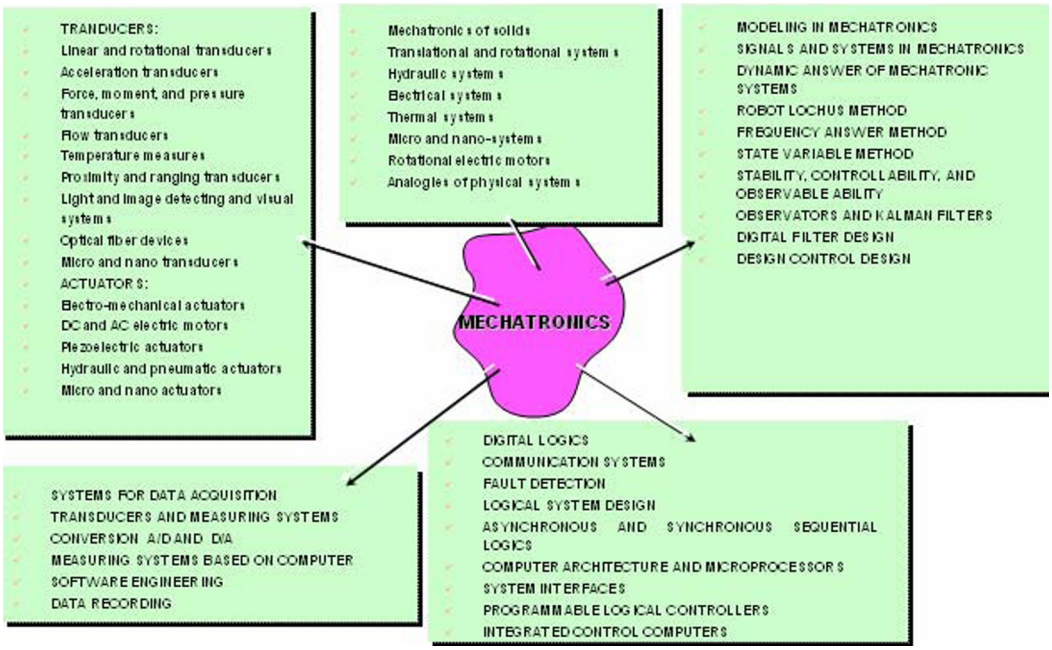

Fig. 2. Key elements and features of Mechatronics

2. OPTIMIZED AND INTEGRATED DESIGN IN MECHATRONICS

Having permanently in view the achievement of a higher quality-price ratio and also the performances a product of relative high complexity has to satisfy, the application of the simulation on physical models at real or reduced scale, which do not allow flexibility, is not appropriate.

The optimization in closed loop is not possible in those cases. Important stages of the presented cycle can be easily done by using a computer. Thus, one has to use high integrated methods of computer aided design (Ionescu *et al*., 1996a). The advantages of the programs in this domain and their integration that are specialized on 3D geometry generation, kinematic and dynamic simulation, static and dynamic behavior analysis, are used. In Fig. 3 the diagram of the integration principle is shown staring with the pre-design and ending with de final product (Ionescu *et al*, 2003; Bostan *et al*, 2003).

Figure 4 shows the information model with multiple loops which allows the design and optimization at different levels. The stages in their sequence are emphasized: project specification, preliminary draft, project achievement, model building for calculation and analyzing with kinematic and dynamic simulation programs MS or SD, result obtaining, checking the validity, finite element analysis (ANSYS), decision on the analysis results, prototype creation, experimental test, optimization and procedure confirmation. The information transfer is realized in multiple lops, the loops of optimization being of great importance (Ionescu *et al*, 2002).

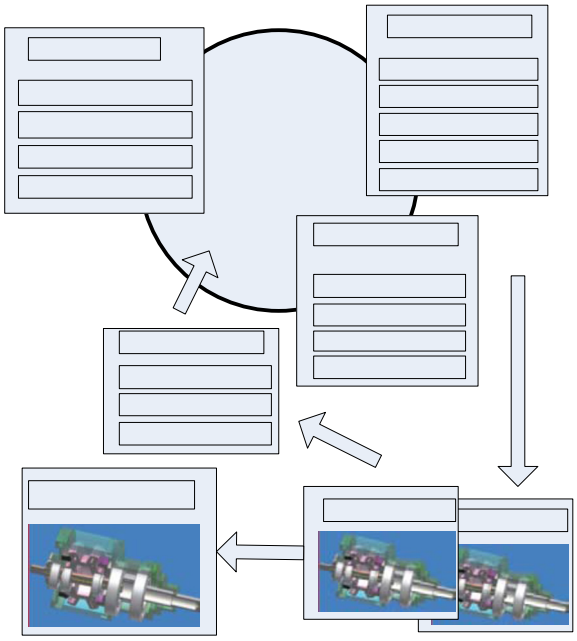

Fig. 3. Process of Developing the Precessional Drive Products using CAD-CAE Platform.

In SD and ANSYS there are internal optimization loops that work on the basis of pre-established performance criteria (not presented in Figure) .

After the pre-project realization, the three dimensional representation is achieved consisting of geometrical characteristics. These have parameters that can be specified in the drawing or calculated as part of the analysis. The geometric calculations are associated to