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Mechatronics

Electronics in products and processes

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Preface

The need for an integrated approach to the design of complex engineering systems involving electronic engineering, mechanical engineering and computing has become increasingly apparent in recent years and has led to the growth of the concept of mechatronics. However, it is a concept which is as yet not particularly well defined; a broad range of interpretations has been placed upon it. The following definition has been adopted within the EEC:

Mechatronics is the synergetic combination of precision mechanical engineering, electronic control and systems thinking in the design of products and processes.

From this definition it is clear that mechatronics is not itself a separate discipline within the overall spectrum of engineering but rather represents an integration across a number of different fields within engineering.

This text is therefore an attempt to set out the nature of mechatronics for a broad engineering audience. In order to achieve this objective the text aims to provide an indication of the range and scope of a mechatronic approach to the design of engineering systems and to identify the major areas of technology involved in such systems. It has its origins in the engineering degree course at Lancaster University and, specifically, in Professor Michael French's concept that engineering design should form a connecting theme throughout the whole of this course. As the course developed it became clear through links wth industry and through involvement in the Cambridge University based advanced course in design, manufacturing and management, for which Lancaster is the northern outpost, that there was an increasing need for engineering graduates who could function in an interdisciplinary environment. This led to the establishment in the late 1970s of a final year option course entitled 'the electromechanical interface' linking the two disciplines specifically in the area of drive technology. Then in 1985 an MEng course in mechatronics was established, the first such in the UK and from which the first graduates appeared in 1988.

The authors were all involved in the definition, setting up and teaching of the mechatronics MEng course and it was from this that the idea came about for

a book bringing together some of the concepts and material from the course. That the book has eventually seen the light of day owes much to a number of people. Michael French, the Professor of Engineering Design at Lancaster University, has already been mentioned and we owe much to his ideas on the nature of engineering design. Tony Dorey, the Professor of Electronic Engineering at Lancaster University, has also provided much advice and encouragement throughout this period, while other members of staff of the Engineering Department have advised and commented on items within the text. Away from Lancaster, many thanks must go to Sid Dunn for reading the manuscript and for his invaluable comments. At Chapman and Hall, Dominic Recaldin displayed admirable perseverance. Indeed, this was particularly notable in view of the problems created by the fact that although all the authors were members of the same department when the book was started, two later left to take up other appointments in Germany and the Midlands respectively. Thanks must also go to those companies who supplied information either for inclusion in the text or as background. It must, however, be emphasized that the opinions and conclusions are throughout the authors' own and do not represent those of the companies concerned.

Finally, thanks must go to the members of the authors' families for putting up with strange hours and bursts of work as deadlines approached and for the support they provided throughout; this contribution was perhaps the most valuable of all.

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Chapter 1

What is mechatronics?

The success of industries in manufacturing and selling goods in a world market increasingly depends upon an ability to integrate electronics and computing technologies into a wide range of primarily mechanical products and processes. The performance of many current products – cars, washing machines, robots or machine tools – and their manufacture depend on the capacity of industry to exploit developments in technology and to introduce them at the design stage into both products and manufacturing processes. The result is systems which are cheaper, simpler, more reliable and with a greater flexibility of operation than their predecessors. In this highly competitive situation, the old divisions between electronic and mechanical engineering are increasingly being replaced by the integrated and interdisciplinary approach to engineering design referred to as mechatronics.

In a highly competitive environment, only those new products and processes in which an effective combination of electronics and mechanical engineering has been achieved are likely to be successful. In general, the most likely cause of a failure to achieve this objective is an inhibition on the application of electronics. In most innovative products and processes the mechanical hardware is that which first seizes the imagination, but the best realization usually depends on a consideration of the necessary electronics, control engineering and computing from the earliest stages of the design process. The integration across traditional boundaries that this implies and requires lies at the heart of a mechatronic approach to engineering design and is the key to understanding the developments that are taking place.

Engineering design and product development are, as illustrated by Figs 1.1 and 1.2, complex processes involving an interaction between many skills and disciplines. Mechatronics is not a distinctly defined, and hence separate, engineering discipline but is an integrating theme within the design process. In achieving this integration it combines, as shown by Fig. 1.3, its core disciplines – electronic engineering, computing and mechanical engineering – with links into areas as diverse as manufacturing technology, management and working practices.

The foundations of a mechatronic approach to engineering design are

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