

Preface

Manufacturing Flexibility is usually considered as the main answer for surviving in present markets characterized by short lead times, tight product tolerances, pressure on costs, frequent changes in demand and continuous evolution of the technological requirements of the products. Even if flexibility can be seen on the one hand as an important strategic option, on the other hand one must consider that the competitiveness of a firm can be strongly affected by the burden of capital intensive investments in system flexibility. Therefore there is the need of viewing system flexibility in the global picture trying to consider both the advantages and the disadvantages related to the acquisition of flexibility.

In particular production contexts characterized by mid to high demand volume of well identified families of products in continuous evolution do not require the highest level of flexibility; therefore, manufacturing system flexibility can be rationalized by finding out the best trade-off between productivity and flexibility. Manufacturing systems endowed with the right level of flexibility required by the production problems are named within the book Focused Flexibility Manufacturing Systems – FFMSs. A great deal of industrial sectors have to face this trade-off including, among the others, automotive, white goods, electrical and electronic goods. Also, the introduction of focused flexibility is not only important for system users but also for machine tool builders whose competitive advantage is based on the ability of customizing their system solutions on the basis of the needs of their customers.

However, designing manufacturing systems that optimally satisfy the production requirements represents a very complex problem. Aspects ranging from manufacturing strategy to risk appraisal and management techniques, and from scenario analysis to system performance evaluation must be jointly taken into account considering the whole system life-cycle. Moreover, traditional system architectures do not always represent the most efficient solutions to properly face the new production context. Indeed, dedicated systems are not able to adapt to changes of the product characteristics while flexible systems often offer more flexibility than what is really needed, thus increasing investment and operating costs. The required level of system flexibility impacts on the architecture of the system and the explicit design of flexibility

can lead to new hybrid systems, i.e. automated integrated systems where the products can be processed both by general purpose machines and by dedicated machines. This is a key issue of FFMSs and results from the matching of flexibility and productivity that characterize Flexible Manufacturing Systems (FMSs) and Dedicated Manufacturing Systems (DMSs), respectively.

Therefore the mission of the book is: “to define methodologies and tools to design production systems endowed with the right level of flexibility needed to face, during their life-cycle, the evolution of products, processes and market demand”. The underlying idea is that flexibility has a cost therefore by using the right level required by the production problem on hand it is possible to find the optimal trade-off between flexibility and productivity.

In spite of the relevance of the production system design topics, existing methodologies and tools do not provide an extensive support to the system designer since they typically deal with sub-problems of the whole design process. Indeed the wideness the topics related to system design can be seen as one of the reasons why this problem has not been sufficiently addressed until now. This work can be considered as an effort to provide an integrated framework to support the design of manufacturing systems that are able to cope with present and forecasted production problems in a cost-effective way. Herein, the main phases of the design activity are jointly structured, starting from the data collection and formalization of production information till the design and performance evaluation of the optimal system solution. Even if the proposed design approach can be applied to different production contexts and different system architectures, the authors have focused the analysis on the design of FFMSs. All the steps of the proposed approach are deeply investigated, and particular attention is paid to the methodologies adopted to face the different sub-problems (including: mathematical programming, stochastic programming, reverse kinematics and simulation techniques). By approaching the various aspects related to the design of system flexibility with formalized techniques and by applying the proposed framework to a set of real and realistic cases it is possible to have some figures of the advantages and costs related to flexibility. These figures even if related to the specific cases considered can provide interesting insights in the pros and cons of flexibility which can be exploited at managerial level.

Most of the methodologies presented in this book have been developed within the two-year project “Methodologies and tools for the configuration of production systems with focused flexibility” funded by the Italian Ministry of University and Research (MUR) and coordinated by Politecnico di Milano – Dipartimento di Meccanica. The project itself is a joint effort of Politecnico di Milano, Politecnico di Torino, Università di Palermo, Università di Catania e Università del Salento. This book is also the result of continuous interactions with suppliers and users of manufacturing systems and in particular, among the others, with MCM S.p.A., Ferraioli & C. S.r.l. Nuova Meccanica S.p.A.

The book structure follows the framework that has been developed to address the system design problem. This framework is both broad and

detailed, since it pays attention to all the relevant levels of an organization that are involved in the system design activity (see Chap. 1). Moreover, the framework models both the point of view of the machine tool builder and the point of view of the system user.

The work presented in this book links together different research fields by means of a shared information formalization (see Chap. 4). The research fields consist of: Manufacturing Strategy (see Chap. 5), Process Planning (see Chap. 6), System Design (see Chap. 7), Capacity Planning (see Chap. 8) and Performance Evaluation (see Chap. 9); moreover, the book gives a contribution to the formalization and rationalization of the concepts related to manufacturing system flexibility (see Chap. 3). The attention to industrial issues is confirmed by empirical studies (see Chap. 2) and real case analyses (see Chap. 10) which are presented within the book chapters to define the production domain where FFMSs are more profitable than traditional system architectures. Finally, some conclusions regarding new machine architectures are proposed to machine tool builders willing to provide innovative system solutions.

As it can be seen from this brief preface, this book is only a step in a very complex and wide field, and it is an attempt, with limits and open issues, to have a joint understanding of system related issues that are frequently dealt separately. Indeed, the interactions among these issues deeply affects the resulting system flexibility and productivity; the comprehension and formalization of these interactions is the key to be able to design systems whose evolution is tuned on the evolution of the processes they implement and the product families they produce.

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