

Preface

This book collects the contributions presented at The New Industrial Organization Workshop, 2015, Valladolid, Spain. It gathered three generations of academics, many of them teaching Economics and Management in Schools of Industrial Engineering in Spanish Universities. It was an undeserved and unexpected tribute to celebrate my retirement as Professor Emeritus of the University of Valladolid. I ought to express my surprise, then, and my gratitude forever to all of them. The topics and the contents of the talks were free and they represent a collective view of Management with an Engineering focus.

Recently, the Industrial Engineering Standards in Europe (IESE) Project defines Industrial Engineering as “The branch of engineering that engages in the study of how to describe, evaluate, design, modify, control and improve the performance of complex systems, viewed over time and within their relative context”. The definition shows the evolution of the field, in scope and focus, far beyond industrial activities, to cover any physical landscape populated by human agents and brings at the forefront the complexity inherent to social agents and their interactions. The focus has changed from product design and manufacturing until the eighties to developing distinctive capabilities of the firm and since the beginning of this century, collaborative management has been replacing management for competition.

These changes have occurred in parallel with changes in information technologies and computational capacity. Simulation in Economics (Artificial Economics) and Computational Organization allows generating bottom-up models, as in the true experimental sciences, complementing the analytical methods at use in Economics and the Management Sciences. The reader may remember the nightmare to calculate the analytical expression of the probability distribution of order statistics, such as the maximum height of a wave to design a pier, or the “fat tails” in economic data. Nowadays to obtain the probability distribution of order statistics, one can run Monte Carlo simulations (for example with Crystal Ball); as simple as this. Even more, these changes are leveraged by sharing knowledge in a free open access way such as the R Project for Statistical Computing or Creative Commons licenses free of charge to the public. Management Engineering can and should

provide the skills and methods to manage complexity not limited to Industrial applications.

We have organized the chapters in four themes. I: Management Engineering and Organizational Sciences. II: The Governance System of the Firm. III: Heuristics, Intelligent Systems and Agent-Based Modelling. IV: Innovative teaching activities in Management Engineering.

In Chap. 1, the author presents a personal view of the evolution and classification of Management and Organizational Sciences. The contribution is very original and it is quite different from the usual academic papers. He has a wide and rich experience as a professor in Business and Economics, in managing public international and national institutions as well as in innovation and technology transfer at the Universitat Politècnica de Catalunya. He is Vice-President of the CYD Foundation and responsible of the yearly published report about Knowledge and Development in Spain. Although there are general principles in Management, he argues that the level and the type of institution determine a range of specific skills and competences. The reader will find that his ideas are well defined and have great practical and academic value.

No account is available, to our knowledge, of the origins and developments of Management Engineering in Spain and its relationship with similar studies in other countries. The authors are a good representation of the senior and young generations of experts in Industrial Organization (I.O). In Spain and in many Latino American countries, I.O is a mix of Technology and Management and it is the main tributary of today's Management Engineering. In Chap. 2, they review the historical background of Spanish Industrial Engineering and its relationship with the corresponding field in USA and in other countries. This chapter covers missing information about the actions undertaken by the first and successive Professors of the Chair Groups that stemmed from the initial "Economics, Organization and Legislation" of the Higher Technical Schools of Industrial Engineers. They end with the chapter presenting ADINGOR (Association for the Development of Organizational Engineering) founded to promote graduates' professional activity, international publications and congresses to gain visibility, helping to consolidate the Management Engineering field.

Economics and Industrial Organization are contextual and evolve. For this reason in Chap. 3, the author looks at the most relevant milestones of a long period of 60 years. The choice, the questions and the conclusions are personal and probably controversial. The chapter starts with the great failure of the Economy: the gap in the distribution of wealth even in developed countries. It continues asking the following questions: What have we learned from the seventies crisis? What are we learning from the current crisis? What was wrong with Economics as a social science? Can Experimental Economics allow us to understand and accommodate the social complexity of the Economy? What is the scope of Artificial Economics? Finally, since Artificial Economics provides solutions to complex problems, can we export socially inspired methods to other areas of Management Engineering? He concludes that there are tools to improve Economics and Management. However, to resolve the current economic and managerial challenges will require changes in

methods and institutions that go beyond Economic Policy and the conventional Industrial Organization. The changes must be rapid and institutional. Not so much improvements in Economic Policy or Operational Methods as changes in Political Economy and Management Engineering.

Although the Economy and the Firm have common goals, Economic Theory has focused on markets and prices; dominated by a neoclassical view, it ignores the complexity of both, the Economy and the Firm. For this reason, Economics provided little help to managers. This fact prompted the raise of the new fields of Industrial Organization and Managerial Economics. In Chap. 4, the authors describe the dimensions of a New Industrial Organization that could help managing the Firm. They point out that the economic activity takes two alternative forms: the Market and the Firm. Economics is a social science that tries to explain how wealth is generated and how it is distributed. The Firm is a social organization whose members decide to cooperate to generate wealth and how it is distributed among the stakeholders. They certainly share a common goal. However, to translate economic principles to management is an open challenge. The traditional I.O., as it is understood among economists, deals with the generation of wealth through a market that, when it is well designed, achieves a fair distribution through endogenous dynamics towards equilibrium. On the other hand, a proper Theory of the Firm needs explicit rules of governance and operations. This fact requires a New I.O dealing with: Uncertainty far beyond probability; individual and collective bounded rational agents; specialization and heterogeneity; imperfect information and variety; incentives and penalties to avoid free riding; and how to develop core competences such as entrepreneurship, innovation and knowledge management. The chapter ends with a map of Management Sciences at the service of the New I.O in the sense of the classification presented in the first chapter.

Management Engineering is concerned with the design of governance systems for an agile and resilient firm. Chapter 5 deals with advances in organizational resilience and it provides a new systemic framework to analyze and design resilient organizations for firms involved in industrial or any other activity. Several works have proposed principles that one should follow to develop resilient organizations and the characteristics that a resilient organization should have. However, after reviewing more than 200 papers, the authors have found that these approaches lack a formal framework to create resilient organizations with capacity of creativity and innovation. A Viable System is a system organized in a way that it is able to survive despite changes in its environment. The theory of Viable Systems (TVS) is a scientific approach based on Organizational Cybernetics applied to the design and study of organizations and its processes. Could the theory of VS provide a formal framework to create resilient organizations? To answer this question the authors map the characteristics of resilient organizations to the characteristics of Viable Systems. They show how the TVS has conceptual and practical tools to design and monitor resilient organizations. They conclude that the TVS provides a formal framework to create resilient organizations.

Two core ideas in the Governance of the Firm are Agency Management in the Economic Theory and the Supply Chain Management (SCM) in Production.

An Agency relationship occurs between consecutive supply chain links. This is an example of convergence towards Management Engineering. Even for a single firm, the Bull-whipped effect showed that a perspective based on local optimization significantly damaged the supply chain performance. SCM needs a systemic approach: “thinking globally, acting locally”. Chapter 6 is dedicated to the Supply Chain Management for the twenty-first century. International trade has been multiplied by four since the year 2001. This means that the cooperation among the agents in the supply chain network, demands a systemic approach. How can SCM be successful in this new complex scenario? The authors discuss these issues and propose a three-legged framework for deploying the systemic (holistic) perspective in the SCM: Education, Orchestration, and Methodology. Education involves the development of a learning model based on analyzing the organizational issues as a whole (breaking down the ‘divide and conquer’ paradigm). Orchestration refers to the design and implementation of systemic solutions in the real world, which considers theoretical foundations, technological tools, and collaborative practices. Last but not least, a methodology to support the decision-making processes while adopting the collaborative scheme is essential to design a system with the desired properties and to align incentives between the different supply chain nodes.

The fourth technological revolution is already here and will involve deep changes in Management Engineering that will extend its scope beyond industry, civil engineering or architecture. In Chap. 7, the authors deal with the effect of these changes in Project Management Methodologies. The new technological revolution is propelled by the development of cyber-physical systems and technologies like Internet of Things, Big Data, Cloud Computing, 3D printing, etc. Therefore, we will see an avalanche of projects to implement new business models, products and services in their companies. They analyze the main characteristics of these projects and they wonder about the appropriate methodologies and managerial styles to lead them. They argue that these projects are complex in nature, according to the current literature on project complexity and thus, classical project management approaches might be unsuitable for managing them. They suggest some clues to seek for new managerial styles, mainly in the literature concerning innovation and new product development and within the “Agile” approach.

The objective of Chap. 8 is to study the implications of knowledge, cooperative relations and business innovation for “The New Industrial Organization” presented and discuss in Chap. 4. From Solow’s seminal article on growth theory, it is known that there is an unexplained growth, labeled as Solow’s “residual”. The sources of the unexplained growth are the intangibles: entrepreneurship, knowledge, increasing capabilities, innovation and networking. Collective intelligence emerges from the firm’s internal and external networking; it is a leverage of the intangible factors effect on growth because trading is a nonzero sum game. The authors present the implications of these intangibles to understand the meaningful connection between Economics, Business Organization and Strategic Management. To this end, they select two intangible factors: knowledge and cooperative relations between the agents of the firm. They are at the basis of business profitability, through their impact on innovation. Innovation exists to convert knowledge into

products and services that will attract the customers. Competitiveness emerges here, when those goods and services are unique and generate value for the customers, who are willing not only to acquire them, but also to pay the set price. The challenge consists in offering, today as ever, products and services that are new, so that the firm will not be marginalized and abandoned by the customers, which are nowadays, agents of the firm's network. Knowledge, together with the innovative capabilities of the managers and employees, open up an enormous space for the firm, which leads to continuous progress full of opportunities and future: an emerging (endogenous) firm's growth.

In a global world, firms understand that cooperation is a key for sustainable innovation. How do the institutional endowment and innovation strategies determine cooperation? Chapter 9 provides contributions to answer this question. Knowledge accumulated inside the firm requires external feedback if the firm wants to reinvent itself. Institutional endowment influences those cooperative processes, acting as a barrier or as leverage. When building balanced cooperation strategies, the extent to which firms make their contributions counts in the innovation race by using "the wind behind" them, and it will determine how sustainable performance is achieved. Understanding the impact of institutional endowment on innovation strategies might reduce causal ambiguity and therefore help firms to contextualize their innovation strategies. The aim of the authors is to contribute with a type of cooperative innovation strategy dependent on three institutional factors: culture, networking and the legal system.

Heuristics and Computational Organization (Agent-Based Models) are new ways to deal with the complexity of the firm. Chapter 10 deals with ongoing research of the authors for improving tools for Nawaz, Ensore & Ham (NHM) Based Heuristics on Permutation and Blocking Flow Shop Scheduling Problems. Heuristics are approaches to operations management problems such as Flow Shop Scheduling that are NP-hard. Determining the best sequence of n jobs processed on m machines in the same order will give us $(n!)^m$ possible sequences. The most efficient heuristics for this problem is the NEH Heuristic. The authors analyze the behaviour of the insertion procedure of the NEH because in some cases the procedure does not improve the solution's quality. This fact occurs specially in the NEH- based heuristics, proposed in the literature of the blocking flow shop problem. Based on their analysis, they recommend evaluating the sequence before and after the insertion phase in order to retain the best of both procedures.

Agent-Based Modelling (ABM) is one of the most active modelling paradigms in many fields to handle the complexity arising in physical landscapes populated by social agents. This is the case with the Economy, or the Firm. ABM provides great advances and it is becoming a core method in Management Engineering. In agent-based modelling, each entity identified in the target system is explicitly and individually represented as an agent, and the different interactions among the agents and the environment are represented as well in the model. As in any experiment, it is always relevant to study the properties of the emerging results and when possible find out the relationship between the ABM and its parametric version. Chapter 11 provides guidelines for the appropriate design of experiments using

machine-learning techniques in the analysis of ABM. This approach allows us to use a supervised learning algorithm to fit the results of the ABM simulations with the parametric representation.

Although agent-based modeling brings opportunities and advantages to Management and Organizational Design, it is a new approach in the management context and it has an important drawback: How to achieve a balance between simplicity and realism? One of the advantages of substituting human subjects by artificial agents, in order to model and manage organizations, is that the agents' behaviour can be controlled and simplified. Chapter 12 provides answer to a core question in organizational design. How alternative organizational configurations influence the emergence of corporate culture? Taking one of the many accepted definitions of corporate culture, the authors build a model to simulate different organizational designs in terms of agents, agent's endowments and scenarios and generate corporate culture. They find that formal organizational configurations are more likely to favour the emergence of corporate culture than informal interactions. The chapter is a nice example of the power of ABM to solve core social questions.

Intelligent Transport Systems (ITS) are fundamental to enterprise competitiveness, especially in terms of the efficiency improvement of Logistics and Freight Transport. Although these areas are commonly associated with the private sector, the public sector has a significant role regarding regulation, and the planning and maintenance of public transport infrastructures. Chapter 13 deals with two innovative areas in which public and private sectors collaborate: gateway facilitation technologies and some projects focused on an innovative management of freight transport. The use and development of ITS can generate significant benefits in terms of transport efficiency, customer satisfaction and environmental sustainability. The involvement of public institutions would be desirable to promote a single ITS standard that would allow the use of these systems.

In the last two chapters, the authors describe recent innovative teaching developments in Management Engineering carried out by them. In Chap. 14, the authors present the Lean School developed by them in conjunction with an industry partner (Renault) to improve the capabilities of the engineering students and employees of companies located in the Castilla-León region. It is a good example of university-industry partnership, where students learn lean tools in a simulated manufacturing environment, and industrial companies interact with universities to help creating world-class engineers and make a significant difference in engineering education. The Lean School Lab is used successfully by both for research purposes and learning-by-doing tool for students and industry employees.

Finally, Chap. 15 is a review of the innovative teaching activities carried out by the authors at the School of Industrial Engineering of the University of Valladolid in the field of Management Engineering. The objective is to promote the process of learning existing paradigms in the field of business organization and also that students acquire and develop the specific and generic skills they will need in their future professional activity. They present a portfolio of innovative projects of different learning methodologies and tools for supporting teaching activities. The chapter ends with a summary table of the improvement activities, which describes

the elements for each action-project. They provide indicators of impact on professional skills and abilities, as well as of the benefits of each action and the contexts of use within the training process.

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