

Preface

OVERVIEW

Today's society, where everyone praises and promotes technological development, it seems to be more critical than ever to review the effect of this quick process of technology growth, not only in industry and sciences but also across our social behavior and, in general terms, over the progression of humankind. Therefore, engineers, business leaders, politicians, entrepreneurs – everyone – should value the opportunity to pause sometimes to consider the consequences of their decision-making, not only with a short-term focus, but also with a long view of the unfolding future. That is where philosophers of science, historians, sociologists and humanities academics may play an important and relevant role for general enlightenment and awakening. In this sense, this book showcases diverse understandings about the new high-tech advances, what they mean to science, society and industry, their challenges, benefits, pros and cons, including the applications of such disruptive technologies.

Together with other prominent thinkers, the Spanish philosopher José Ortega y Gasset is considered one of the founders of the philosophy of technology. Ortega y Gasset, in his work *Meditation of the Technique*, affirmed that the first methods of human perfection were the tools created to supply solutions to the intrinsic deficiencies of the human species, such as the use of skins to maintain body temperature, or the use of sharp blades to cut meat or hunt animals. According to his thought, technology should allow three goals: ensuring the satisfaction of human needs, achieving such satisfaction with the minimum of effort and, finally, producing objects and services that provide new possibilities to the human being.

Handbook of Research on Industrial Advancement in Scientific Knowledge has been conceived of broadly to explore these goals, affording a global vision over the nowadays digital transformation. Consequently, the reader will identify throughout these pages methodologies and applications related to decision making, risk and uncertainty, as well as design and development, not only on scientific and industrial topics, but also on social and ethical matters. In other words, we present here a compilation of chapters that address different edges related to technology and science, where engineering considerations, mathematical approaches as well as management tools provide a better understanding and awareness of the so-called Industry 4.0, taking into account at the same time the impact of such novelties on our current society and its perception.

SUMMARY OF TOPICS

Industry 4.0 refers to a fourth generation in the production and manufacturing activity of the commonly named Fourth Industrial Revolution, characterized by the application of intelligent systems and solutions based on the Internet of things, big data, augmented reality, etc. Due to the relevance of technology in our fashionable world, this publication aims to be an useful reference source that provides a wide range of deliberations, showing diverse understandings of the new high-tech advances and paradigms, what they mean to science and industry, their challenges, benefits, pros and cons, including adapted and updated applications of disruptive technologies.

In addition to this, uncertainty and risk are important matters from the point of view of organizations and individuals. Nowadays, the application of advanced technology to traditional and accepted scientific method may allow a better characterization of uncertainty, and reduce risk in decision-making. In general terms, the treatment, for example, of large amounts of data is a novel contribution to empirical logic and to the characteristics of the techno-science concept. Consequently, it is pertinent to research the effects of the new term Industry 4.0 on decision-making, particularly how this digital transformation may reduce the uncertainty and risk associated with choosing between alternatives. Invariably (and sometimes in a subconscious way), we make decisions based on a background of risk analysis in which the decision maker, according to their particular way of pondering alternatives, tends favorably in one way or another. Of course, there is no generally accepted way to assess uncertainty and, in practice, there is no consensus on what uncertainty and risk mean. That is why this book is also intended to study the concepts of uncertainty and risk under the new paradigm of Industry 4.0, aiming to suggest proposals for a techno-scientific method.

Finally, the reader will find a more humanistic and reflexive view of technology, particularly in the fields of logic, philosophy and history of science. In a few words, this book discusses Industry 4.0, and how it affects scientific research, manufacturing activities, business and social development, together with a humanistic perspective of this emerging technology disruption. Undoubtedly, this is a vast and challenging scope of research, so it has been observed along chapters written from many different angles.

The main topics here are related to a theoretical and practical view on advanced technologies and their inference to scientific knowledge, industrial development, as well as social advancement:

- Industry 4.0
- Techno-science
- Risk and uncertainty
- Decision making
- Logic and Philosophy of Science;
- Digitalization
- Advanced and disrupted technologies
- Industrial assets management
- Globalization of science
- Scientific method
- Social Implications of techno-science
- Barriers to high technology and transhumanism

The above categories have also attracted pragmatic contributions that provide areas of application with great and feasible importance. These areas include:

- Mining investigation
- Automotive sector
- Smart grids
- Project management
- Hospital maintenance
- Petrochemical industry
- Buildings legislative policies

TARGET AUDIENCE

Handbook of Research on Industrial Advancement in Scientific Knowledge is aimed at worldwide readers, from business leaders to academicians. In fact, this book analyzes an interesting variety of subjects, providing an in-depth look at current global concerns on technology, science and social matters.

Therefore, scientists, engineers, academics, economists, researchers, science philosophers, technology developers, managers and others who take decisions on scientific and industrial fields will find this text useful in furthering their research or work in those areas pertinent to innovative emerging technologies.

IMPORTANCE OF EACH CHAPTER

Due to the fact that today's technology affects all aspect of human life, *Handbook of Research on Industrial Advancement in Scientific Knowledge* is a mix of relevant and diverse studies with many different and enriching points of view. Therefore, it can be structured in three parts or sections, although the boundary lines between such parts are not strictly and completely impermeable, and there are chapters that present characteristics from other sections:

- The first selection consists of six chapters (Chapters 1 to 6), which include theoretical aspects of technology, some of them from a humanistic, social and philosophical point of view.
- The second section consists of five chapters (Chapters 7 to 11) with contributions that deal with technology from a more engineering focussed and scientific perspective.
- Finally, the third section consists of seven chapters (Chapters from 12 to 18), which considers practical aspects, industrial cases and, in general terms, applications of current technology to very diverse areas.

A brief description of the eighteen chapters, with regard to their research material and the conclusions reached, are collected and summarized as follows:

Section 1

Chapter 1, “Technodata and the Need of a Responsible Industry 4.0,” presents the historical roots of the interest to adapt business models that rely on data, due to emergence of the Web 2.0 after the dot.com crash and, afterwards, the consolidation of the platform economy on the Internet, and how the development and introduction of these digital innovations must be aligned to societal expectations for not provoking exclusions and displacements of stakeholders in industry, economy and society.

Chapter 2, “Exploring the Effect of Emerging Technologies on Scientific Knowledge Production and the Industrial Advancement of Society,” focuses on a kind of state-of-the-art, where new technologies and tools are depicted, in order to provide a view of the effect of technology over science, engineering, and the society in general terms. This chapter presents how, in the Fourth Industrial Revolution, the cybernetic infrastructure will play the same dynamic role played by the railroad in the first revolution and promote the inclusion of innovation and new technologies as the foundation of the new knowledge-intensive industry.

Chapter 3, “Decision Making Under Uncertainty and Risks in the Face of Rapidly Advancing Technologies,” describes a general research framework combining technology-oriented risks and social aspects, linked with their perception in terms of impact or ethical standpoints. Along this chapter, the general context of risk-based decision making is depicted, supporting the chosen arguments with a historical and somewhat scientific state of the art in a very relevant manner.

Chapter 4, “Technological Revolution, Transhumanism, and Social Deliberation: Enhancement or Welfare?” analyses how technological development can lead to substantial changes in our own nature without control, implying to take risks that must be anticipated and obliging us to make decisions in the most open and consensual way possible.

Chapter 5, “Human Perfection and Contemporary Enhancement Technologies,” shows how the main positions regarding the use of biotechnology on the human being—represented by the bioconservative and posthumanist currents—are very far apart, opening a large gap between those who are in favor of biotechnological improvement of a perfectionist nature and those who reject it. A fundamental part of this research is to analyze the possible risks and consequences of non-therapeutic biotechnological interventions.

Chapter 6, “The Society of the Digital Swarm: Microblogging and Construction of Subjectivity in Homo Digitalis,” performs an analysis on the changes brought by the digital revolution of the Web, the proliferation of social networks and virtual communities, as well as the intensification of microblogging that have greatly transformed our habits, lifestyles and ways of communicating with others, and how a global digital citizen should contribute to an authentic information and knowledge society as a responsible person with rights and duties.

Section 2

Chapter 7, “Racing Ahead With Innovation and Ethical Decision Making: The Case for Hybrid Modelling and Simulation,” explores how developing anticipatory models may be used to understand the structure of complexities that are part of the societal and technological change, although the fact that it is acknowledged that these models can never be complete or absolutely accurate. The position taken in this chapter is that it is crucial for innovation to emerge to teach critical reflection to ground perspec-

tives (models, narratives), to remain open to different views, to acknowledge limits to knowledge, to be playful and humble and to ingrain value directives that capture these elements.

Chapter 8, “Towards an Industry 4.0-Based Maintenance Approach in the Manufacturing Processes,” introduces how Industry 4.0 accepts the challenge of addressing new concepts of maintenance with numerous efforts on its implementation in various systems. Intelligent Maintenance Systems have brought new paradigm shift to an in-machine renovation and repair. The aim here is to have fully automatized system in order to make a machine capable of reconfiguration, compensation, and, in the last stage, self-maintenance.

Chapter 9, “Assessing HRO Principles for Reliable Performance in Asset-Intensive Organizations: Expecting the Unexpected,” sets out the HRO concept (High Reliability Organizations), as a result of an increase in the complexity of physical assets due to the Fourth Industrial Revolution, and how they can benefit from a mindful infrastructure for high reliability to manage higher levels of uncertainty.

Chapter 10, “Anticipation of Problems in Innovative Projects Based on OTSM-TRIZ,” provides insights into an operative algorithm that has been elaborated in order to guide the selection of the optimal project development route, when it is necessary to integrate new technical solutions. The findings and lessons gained present two types: the algorithm effectiveness and the usability level, in order to follow a systematic approach that aims to guide the data analytics, together with the identification, and problem resolution.

Chapter 11, “Design Knowledge Development and Additive Manufacturing Systems: How Does Design Knowledge Change With Design for AM?” broadly predicts two key new areas for product designers to apply their knowledge and practical skills in an Industry 4.0 environment, and depicts the adoption of new technology as a key step for any manufacturer wanting to stay relevant as the world transitions to Industry 4.0. The digitalization of manufacture and the advance of Additive Manufacturing (AM) technologies, which are important elements of Industry 4.0, have become part of a globally accepted reality.

Section 3

Chapter 12, “To Mine or Not to Mine? Using Game Theory to Explain the Decision-Making Process in Asteroid Mining Investigations,” presents a complex model defined to describe the multifaceted science-industry interaction, typical of techno-science, and how a more important role of technology shall be expected in the future, leading to more complex interactions between science, industry, and governments.

Chapter 13, “Innovation in Scientific Knowledge Based on the Forecasting Assessment: A Case Study on Automotive Spare Parts Demand,” focuses on the study of forecasting methods on scenarios characterized by having an intermittent demand, together with usually great amounts of data. Particularly, this study analyzes methodologies like the Moving Averages method, Holt Winters’ Exponential Smoothing method, and Rolling Grey’s method, in order to provide performance indicators though statistics and big data analytics.

Chapter 14, “Decision Making for Energy Management in Smart Grid,” captures the state of information support according to the analysis of the current situation and the actual problems of determining the place of an energy smart grid in the Industry 4.0. This research refers also to those risk and uncertainty during making decision on energy management and information systems in renewable energy based smart grid.

Chapter 15, “Application of MSTAM Methodology in Project Management: A Case Study of ITF Robotic Automation R&D Project,” analyses how factors like time, quality, control and other motivating

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factors are the main critical aspects affecting the projects commercialization in Logistics and Supply Chain Industry. Particularly, this study is using MSTAM (Market, Science, Technology, Application, and Market) methodology to apply in the Innovation and Technology Fund projects, in order to develop a solution for helping the industry to adopt the R&D deliverables in the Logistics and Supply Chain Industry in efficiency and effective way.

Chapter 16, “Data-Driven Decision Making to Select Condition-Based Maintenance Technology,” shows how the choice of technology should take into account economic, technical, environmental, human resource and political matters. These questions may be addressed simultaneously by applying Multi-Criteria Decision Analysis (MCDA) techniques. In fact, this Chapter describes an objective model built with the fuzzy Analytic Hierarchy Process (FAHP) for choosing through data analytics the most suitable technology in a specific area, being the model applied to a Health Care Organization.

Chapter 17, “Decision Making in the Choice of Condition-Based Maintenance Techniques in a Subsidiary of a Petrochemical Company,” performs a multicriteria decision model using an approach that selects the most appropriate predictive technique and technological level, providing a model application to a petrochemical plant. According to the authors, despite the importance of the various aspects involved in introducing a Computer Based Maintenance programme to achieving good results, the number of contributions analyzing these matters is still very small.

Chapter 18, “The Implementation of Nearly Zero Energy Buildings (nZEB) in Spain: Legislative Requirements and Policies,” explores the implementation of new technologies in order to achieve high level of energy efficiency in buildings. This chapter analyses the legislation associated to Nearly Zero Energy Buildings (nZEB) in Spain in order to identify the factors that will leverage their massive implementation, especially in social housing. As occurred when implementing new technologies in organizations, this matter requires defining a national nZEB roadmap in order to identify the intermediate steps and the final goal.

CONCLUSION

The chapters listed above have been written by around 40 authors from the five continents (Australia, Chile, China, India, Italy, Netherlands, New Zealand, Russia, South Africa, Spain, Sweden, Ukraine). This diversity provides a more complete view of the state-of-the-art in technoscience around the world. Among the members of the editorial board and authors who have participated in *Handbook of Research on Industrial Advancement in Scientific Knowledge*, there are professionals involved in academic activities, engineering, manufacturing, asset management, commercial business, etc., bringing a reasonable and technical vision to the topics gathered in the book. Hence, the present compilation has provided space for diverse and assorted collaborations, together with case studies related to the phenomenon of the Fourth Industrial Revolution, its new technologies, their application to different sectors, as well as scientific advances and research works in real contexts.

As expected, there are also many participants from philosophy, ethical and social branches of knowledge. They motivate improvements, advances and new references from a humanistic perspective, fulfilling the orientation of the research towards society, which is a relevant value added by *Handbook of Research on Industrial Advancement in Scientific Knowledge*. Thus, there is a significant flow of ideas and experiences through this diversity of collaborators who have contributed to the book.

As a general view of the book, the main points developed throughout the chapters can be summarized for example in the following ones:

1. The development and prominence of ethical decision making and what are the moral guiding for that.
2. Uncertainty increases, but the techniques for dealing with risk increases as well, providing this book some good principles.
3. Project management and manufacturing will change and, similarly, there are some guiding lines to adopt mentioned along the chapters.
4. Collaborative decision making and problem solving will be the norm, being clear that management paradigms will change in all sectors.

To summarize, general ideas are emerging from this book, thus individuals and teams will require reflexive practices in order to keep organizations focused on outcomes that consider the long view of the future.

The editors wish to thank all those who have contributed to the development and success of this book, since their research work as well as suggestions, comments and ideas provided are really enriching for all of us, seeding meaningful developments in knowledge, technology, and philosophy of science.

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