

Preface

We are living in a time when Man—perhaps as a result of a body of knowledge that, more often than not, feeds from itself with only little consideration for the changes around—flatters himself with the belief of being not only more informed and intelligent, but also *wiser* and capable of making ever better decisions—to the extent of moving the entire species into what may seem to emerge as a new epoch—an Anthropocene, of sorts. True indeed: in the years since World War II, remarkable advances in domains such as materials, food, medicine, transportation, and communications have changed lives and habitat in manners effective and significant enough to leave lasting marks on longevity, standards of living and—some would contend—the very human condition at the planetary scale. At the same time, however, as by the curse of an unforgiving balance of evils against goods, a whole series of events have exposed, especially over the past two decades, surprising and transcultural weaknesses in the society foundations, fabric and functioning, and in the much-sought shared world order. From natural disasters of unprecedented violence to industrial accidents of the range of black swans, to terror through self-appointed martyrdom ominous signs are increasingly piling up indicating that something is utterly wrong—with nature, with ourselves and, most probably, with what one does to the other. Organizations as well as individuals that were once considered reliable and trustworthy turn out to be fragile, vulnerable, inconsistent, incompetent when not downright corrupt and, in the end, inconsequential in the face of the turbulence and unpredictability that seem, today, to be the name of the game.

In the face of the recurrent failure to identify and implement effective solutions via traditional, disciplinary approaches, one thought commonly attributed to Albert Einstein, looms large upon us: *We cannot solve our problems with the same thinking we used when we created them.* In all honesty, one should confess that there is a long way from noticing the need above to understanding what exactly this means; and the more—should be done; and how. The only pervasive feeling is that any attempt to make sense of the issues, must involve *thinking out of the box* and originating unconventional approaches that may hopefully integrate their organizational, managerial, social, political, cultural, and simply human aspects and their

interplay. Moreover, when targeting a problem identified in a given system, we should perhaps also ‘look sideways and open our minds to other places’ that display similarities in structural patterns and dynamics; and thus, conjure the power of the analogies in the attempt to reveal an underlying ‘business logic’ of different facts and phenomena, which would make those intelligible. For a belief that authors of the present text hold is that most of the other ways of confronting the threats and anxieties of our times can only serve to further boost what Joseph Tainter refers to as a *Runaway Train*. In a Runaway Train model, a society is seen as a complex system ‘*impelled along a path of increasing complexity, unable to switch directions, regress, or remain static. When obstacles impinge, it can continue in only the direction it is headed, so that catastrophe ultimately results*’ (Tainter 1988, p. 59).

Taking a Runaway Train from its fatal course to another timeline is nothing less than changing history. And even though ‘ending’ the Cold War and alleviating an all-out nuclear confrontation had the semblance of being just that, it only took a couple of decades to realize that we are all far away from being off the hook. And the explanation is almost inescapable: to switch the tracks takes more than one lever to be acted upon—one has to pull many levers; and all of these should be critically important, effective, and working in harmony to the same end. The landscape for this train might as well involve seemingly inescapable effects of globalization, the shift of individual markets, and a sheer number of reactive government regulations where nothing can be anticipated, let alone planned for. It is in this context that this book offers a number of thoughts on topics that have emerged in the last three to two decades and fast in migrating from the academic debate to the forefront of the political agendas: *the critical infrastructures*.

To these authors, *critical infrastructures* are systems ‘so vital and ubiquitous that their incapacity or destruction would not only affect the security and social welfare of any nation, but would also cascade [send disruptive waves] across borders’ (Gheorghe et al. 2007, p. 6). While history, cultural differences, and current realities may trim in specific ways, the lists of critical infrastructures and their designations, the inventory would generally cover—without being limited to—the Chemical Sector; Commercial Facilities Sector; Communications Sector; Critical Manufacturing Sector; Dams Sector; Defense Industrial Base Sector; Emergency Services Sector; Energy Sector; Financial Services Sector; Food and Agriculture Sector; Government Facilities Sector; Healthcare and Public Health Sector; Information Technology Sector; Nuclear Reactors, Materials, and Waste Sector; Sector-Specific Agencies; Transportation Systems Sector; and Water and Wastewater Systems Sector (USDHS 2016).

The motivation for this research is two-fold. First, our problems as discussed are not likely to go away anytime soon. In fact, both the literature (see, e.g., Ansoff 1984; Cohen and Ahearn 1980; Martin 2006; Rasmussen and Batstone 1989; Richardson 1994; Tainter 1988; and Weick 1988) and the news reports continue to remind us that violence, crime and war, lawlessness, mismanagement, natural disasters, and gross depletion of resources—to name just a few matters of concern, are increasingly frequent and severe. At the center of it all is the public well-being. The book attempts to delve into this complex and sometimes controversial issue by

highlighting *the need for good governance* involving concepts of, among others, vulnerability, resilience, and fragility in addressing *what is good for the many*. Second, there is a need to ‘do something’ about all these, for doing nothing can only let the Runaway Train slide down toward the predictable catastrophic dead end ahead.

Our ‘doing something’ comes in the form of offering *research models* as tools to understand, that is—to diagnose and predict, the behavior of the complex techno-socio-economic systems at hand in the debate. Faithful to our own beliefs, most of the models embody analogies with emblematic models in physics, with which the critical infrastructures—as well as the society itself and its paraphernalia—share the profile of what is known as ‘many-body systems’ featuring ‘cooperative phenomena’ and ‘phase transitions’—the latter usually felt as disruptive occurrences. Inevitably, our models are rather educational in nature and scope. Although originated over a number of years now in an academic environment, they are the products of authors’ propensity *to place the analytics in general, and the visual analytics in particular at the fingertips of the real-life-business actors*—policy makers, financiers and insurers, industry managers, emergency responders, and the like.

These models are instrumental in understanding how the world operates and in terms could inform the means for managing complex situations, instituting change, and empowering people society’s well-being. The challenge at hand is enormous: systems, their element, and dependencies as well as interdependencies are often unknown, not measured properly, data privacy, and data protection are frequently misunderstood and confused with transparency, systems are not well documented, just to name a few. As a result, living in a ‘system of systems’ world, let alone ‘managing and controlling’ is a daunting endeavor, leaving bruised, those who are brave.

Interestingly, and as a solid proof that every subject matter has, eventually, it’s right time, it is about now that the following *Top 10 Business Intelligence Trends for 2016* are formally recognized: (i) governance and self-service analytics become best friends, (ii) visual analytics becomes common language, (iii) data product chain becomes democratized, (iv) data integration gets exciting, (v) advanced analytics is no longer just for analysts, (vi) cloud data and cloud analytics take off, (vii) analytics center of excellence becomes excellent, (viii) mobile analytics stands on its own, (ix) people begin to dig into IoT [Internet of Things] data, and (x) new technologies rise to fill the gaps (Tableau 2016).

As such, this book may prove to be a useful read for a variety of readers interested in navigating the foggy waters of ambiguities and uncertainties of the twenty-first century. At one end, business leaders and policy makers may find it insightful in matters of say, investments in critical infrastructures, key resources, and key assets (CIKRKA). At the other end are our dear graduate students, who often work on the testing grounds of theories and models that, in time, may turn into real-life applications—it is only fair that we plant seeds now in their minds.

With this audience in mind, seventeen chapters and seven appendixes have been developed.

In Chap. 1, the underlying notions of critical infrastructures, key resources, and key assets are introduced, with emphasis on relevance to the topics of safety and well-being in the twenty-first century. The elements of space, undersea, and belowground are discussed as exemplary cases of new, complex, and critical theaters of action, each combining in a natural fashion the three-fold condition of critical infrastructure, key resource, and key asset. In addition, this chapter establishes a need for extending the traditional risk approach by going beyond mere probabilities and consequences, to the insightful concepts of vulnerability, resilience, and fragility.

Chapter 2 deals with a conceptualization of governance, first introduced in Chap. 1. Specifically, a need for a flexible many-faceted governance strategy for a diverse set of stakeholders is articulated. To that end, this chapter covers models for structural, operational, managerial, and national vulnerabilities in a ‘community’ setting that enable the dynamic capability to master organizational inefficiency.

Chapter 3 addresses the concept of hysteresis. The chapter looks at the importance of hysteresis as well as its implementation in a quantitative model—QVA—for an assessment of cooperative behavior, given the tendency to resist stress and maintain system state configuration.

Chapter 4 provides a ‘system of systems’ model of the world. This is done using readily and publicly available data from the *CIA’s World Factbook*.

Chapter 5 explores the applicability of cellular automata as a viable approach for assessing risk and vulnerability with emphasis on three aspects: forest model, fire model, and smoke.

Chapter 6 is concerned with the application of QVA: *Quantitative Vulnerability Assessment* model to a nuclear reactor vulnerability assessment.

Chapter 7 offers a game approach to dealing with an emerging threat to space systems (i.e., satellites) is presented including scenario model that could be used to shot down such systems.

Chapter 8 offers insights into methods and tools that can be used by managers, political pundits, policy makers, scientists, and even hackers, to make decisions, even without having full knowledge of complex situations.

Chapter 9 offers insights into a model for assessing the vulnerability of territorial kind due to emissions. The procedural agenda for the model is discussed along with break points for chemical and radioactive release.

Chapter 10 provides a *System Resilience Governance Profile* developed for the management of complex situations along with its governance architecture as well as its calculations. A model-driven approach to resilience, complementing, System Resilience Governance Profile is provided in Chap. 11. This model, dynamic in nature, offers utility in understanding current, future, and intermediate situations involving critical infrastructures.

Chapters 12–15 are application-oriented chapters supporting theories presented in the preceding chapters. These applications range from applications at the national level—Switzerland (Chaps. 12 and 13), to specific systems—the cases for Sihl Dam (Chap. 14), to airflow dispersion in complex terrains in urban areas (Chap. 15), to regional vulnerability—Germany and EU (Chap. 16). The last chapter (Chap. 17)

offers insights into proposed research along methodological, epistemological, ontological, and nature of man.

The book also contains a set of appendices are meant to complement the book chapters. These include a hierarchical holographic vulnerability assessment model, notes on an emerging domain of *Complex System Governance*, an expert-oriented tutorial for systems many bistable entities, a mix-game elaborating QVA model, a listing of systems theory-based pathologies, lexicography for threat index, and introductory notes on VulPet—a software platform for assessing vulnerability in petrochemical plants. A glossary of terms, based on the 2013 National Infrastructure Protection Plan (USDHS 2013), concludes the matter.

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Risk, Vulnerability, Resilience, Fragility, and Perception
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