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Systems Thinking

Intelligence in Action

 Springer

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ISSN 2280-1464 ISSN 2280-2088 (electronic)
ISBN 978-88-470-2564-6 ISBN 978-88-470-2565-3 (eBook)
DOI 10.1007/978-88-470-2565-3
Springer Heidelberg New York Dordrecht London

Translation from the original Italian edition “Guida al system thinking”
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Library of Congress Control Number: 2012932248

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Printed on acid-free paper

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Preface

If man made himself the first object of study, he would see how incapable he is of going further. How can a part know the whole? But he may perhaps aspire to know at least the parts to which he bears some proportion. But the parts of the world are all so related and linked to one another that I believe it impossible to know one without the other and without the whole. [...] Since everything, then, is cause and effect, dependent and supporting, mediate and immediate, and all is held together by a natural though imperceptible chain which binds together things most distant and most different, I hold it equally impossible to know the parts without knowing the whole and to know the whole without knowing the parts in detail. (Blaise Pascal: thought 72).

Fight for your opinions, but do not believe that they contain the whole truth or the only truth.

(Charles Anderson Dana)

THE ORIGINS – This book represents the continuation and completion of my previous work *From Systems to Systems Thinking* (Italian Ed., Franco Angeli, Milan, 1997), which focused on an analysis of the concept of system as a premise for arriving at Systems Thinking. The present work instead develops the concept and techniques of Systems Thinking. Content-wise the book stands on its own, since it presents the basic concepts from the previous work and does not assume that the reader has any prior knowledge of systems logic. It is a book “for everyone”, graded in order to instruct rather than to inform.

THE ASSUMPTIONS – The book has three premises:

1. Intelligence is the ability to develop a system of coherent and meaningful models that allow us not only to survive in a world that is continually evolving but also to improve ourselves and make progress.
2. The most powerful and effective models are the systems ones that view reality as a set of connected and dynamic parts forming a whole. An understanding of the connection between the parts and the whole and their dynamics is the fundamental characteristic of operational and creative intelligence.

3. The most interesting and useful connections among the elements that make up reality are *not the linear* ones – characterized by chains of *causes* and *effects* – but the *circular* ones, the *feedbacks* and *loops*, which make the elements not only connected but also *interconnected*, not only dynamic but also *interactive*. The only efficient thinking is *Systems Thinking*.

THE FIVE RULES OF SYSTEMS THINKING – This book is based on the important work by Peter Senge, *The Fifth Discipline*, but it provides a personal interpretation – and one that, in many respects, is innovative – refining not only the concepts but also the techniques for constructing models of systems dynamics: that is, the Causal Loop Diagrams. In particular, I have based the entire development of Systems Thinking on five fundamental RULES.

First rule: if we want to understand the world we must be able to “see the trees and the forest”; we must develop the capacity to “zoom” from the *whole* to the *parts*, from systems to components, and vice-versa.

Second rule: we must not limit our observation to that which appears constant but “search for what varies”; the variables are what interest the systems thinker. However, we must not limit ourselves to explicitly stating the variables we consider useful but must be able to measure the “variations” they undergo over time.

Third rule: if we truly wish to understand reality and change we must make an effort “to understand the cause of the variations in the variables we observe”; we must form chains of causal relationships among the connected variables.

Fourth rule: it is not enough to search for the causes of the variations we observe; we must also “link together the variables in order to specify the loops among all the variations”. In other words, we must move from the causal chains to the systemic *interconnections* and from the linear variations to the systemic *interactions* among the variables of interest.

Fifth rule: when we observe the world we must “always specify the boundaries of the system we wish to investigate”.

THE OBJECTIVES – The book is designed to allow the reader not only to acquire simple information on Systems Thinking but especially to permit him to gradually learn the logic and techniques that make this way of thinking an instrument for the improvement of intelligence. Systems Thinking, precisely because it is a tool of understanding, must be learned gradually through practice and continual improvement. It is a discipline that requires the systems thinker to have a deep knowledge and to constantly apply its rules, as well as to have the willingness to continually improve: “A discipline is a developmental path for acquiring certain skills or competencies. [...] To practice a discipline is to be a lifelong learner. You ‘never arrive’; you spend your life mastering disciplines” (Senge 2006: 10).

THE CONTENT – The content of the book is presented in four chapters.

Chapter 1 presents the logic of Systems Thinking and the five rules on which it is based, emphasizing the importance of the search for relationships and variations in the observed reality.

Chapter 2 transforms the logic of Systems Thinking into schematic models, adopting the technique of arrows to represent processes of any kind that connect two variables. The processes are black boxes and the arrows that connect them show relationships – in terms of direction and orientation – between the input variables (arrow’s tail) and the output variables (arrowhead). A dynamic system of whatever size and complexity can thus be represented by an appropriate grid of arrows that expresses the causal relationships among the component variables (Causal Loop Diagram). By examining the direction of the variations of the variables we can understand – at least qualitatively – the dynamics of the entire system.

Chapter 3 presents the general logic of control systems, which are the most common, useful, and utilized systems in everyday life as well as in economic organizations. In this chapter the concepts of control strategy and policy are formalized.

The fourth and last chapter treats the use of Systems Thinking in decision-making theory, demonstrating how the logic of Systems Thinking provides useful indications for individual and organizational decisions.

THE STYLE – In order to aid the learning and practice of the Systems Thinking discipline I have felt it opportune to abandon a rigid formal language for a more discursive style, in the first person, with an ample number of citations and critical analyses, without ever giving in to the temptation of using formal mathematics. I have made wide and varied use of causal diagrams in order to refine the reader’s intuition in creating models and to develop the rigor of intelligent thinking. I have highlighted a limited number of rules to aid in understanding and memorization. The work is completed by several discussions and references regarding the discipline of simulation – that is, System Dynamics; the reader is encouraged not to be daunted by the simulation tools, which are very powerful but not always intuitive in their application, and is stimulated to create simulation programs through Excel files, which are simpler to use but not for this reason any less effective.

THE METHOD – In writing Systems Thinking I have tried to focus on its logic and method rather than its techniques. Though considerable, the technical aspects have been treated step by step, in the attempt to enable the reader to understand how the formal language facilitates the understanding of the interconnections among the variables that make up systems and, more specifically, models. For the construction of Causal Loop Diagrams I have adopted modern symbols, which use the letters “**o**”, “**s**”, [**R**], and [**B**] (the meanings are clarified in Chap. 2), rather than the signs “+” and “–”, which make it difficult to understand the causal diagrams. The chapters and sections directly include numerous citations which allow the reader to integrate the basic notions with the ideas of a number of important authors.

I have presented a wide variety of examples in the fields of physical, biological, social, and organizational systems. The theoretical treatment is rounded off by several short but detailed appendices at the end of each chapter.

A BRIEF BIBLIOGRAPHICAL NOTE – Though a relatively recent discipline, the literature on Systems Thinking is vast. I have thought it appropriate to make direct reference to the works of Peter Senge and those of the most well-known thinkers in the discipline. I have also chosen to cite many publications found on the Internet so that the reader can more easily become familiar with the ideas of the authors and verify the content of the bibliographical sources presented. The bibliography is limited to listing only the works cited in the book.

There are several editions of Peter Senge’s book, *The Fifth Discipline*, which are not all exactly alike, due to the changes the author has made over the years.

The first edition was published in 1990, with a subsequent one published in 2006. The citations refer to both the first edition in 1990 as well as the second one in 2006.

WHO THE BOOK IS AIMED AT – The book is for everyone. Numerous examples involve the systems we find in organizations and companies, so that the text can aid the professional growth of managers, consultants, and company personnel in general.

No prerequisite is required to read and understand the book. In particular, knowledge of math and computers is not necessary. A basic knowledge of Excel will help in constructing models for the elementary simulation of simple systems in order to improve understanding.

The use of professional dynamic model construction (Powersim, iThink, and others cited in the book) is useful for those readers who wish to translate Systems Thinking into actual operational models of quantitative simulation. Such programs are not of immediate and intuitive use and thus require further practice and discipline in order to learn their logic, instruments, and typical constraints. Nevertheless, I have felt it useful to present several simple models translated into Powersim (ACADEMIC).

READING STRATEGY – The four chapters are relatively self-contained, and each can thus be read independent of the others. However, I suggest the following order:

Readers approaching Systems Thinking for the first time	Chaps. 1 and 2, and Appendix 2.1.
Readers with a basic knowledge of Systems Thinking	Chaps. 1 and 4 and Appendix 1.1.
Readers who have read Peter Senge’s <i>The Fifth Discipline</i>	Chaps. 1, 3, and 4 and Appendices 4.1 and 4.2.
Readers wishing to have a complete and innovate perspective of Systems Thinking and, above all, who have the desire and time to learn the discipline	The entire book

A NOTE TO THE READER – *In order to attain mastery in the Discipline of Control you must read this book “slowly” and refer the standard models presented in it to your own world and your own experience.*

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