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Ugo BARDI, *The Seneca Effect. Why Growth is Slow but Collapse is Rapid*, Springer 2017, XII, 203 pages

Ugo Bardi's book, as one of the latest reports to the international think-tank Club of Rome, may be of interest to readers from various academic fields and approaches such as development economics, environmental economics, system dynamics, chaos and complexity theory, game theory, etc. The book is part of Springer's Frontiers Collection that discusses challenging and open problems at the forefront of modern science. It fits the well-established literature of system thinking and world modelling. Although the topics discussed in the book are highly scientific, the language is articulated in a non-academic manner in order to be accessible to non-specialist and non-academic audiences as well. From its multi- and interdisciplinary viewpoint, the book discusses the basic feature of collapses. The expression "Seneca Effect" refers to a line written by the ancient Roman philosopher Lucius Annaeus Seneca: "Fortune is of sluggish growth, but ruin is rapid". Indeed, the lifeline of complex systems, either natural or social ones, usually follows a particular and strongly asymmetric bell-shaped curve which grows slowly and declines rapidly.

The Seneca effect. Why growth is slow but collapse is rapid presents a rich collection of historical and contemporary examples for this seemingly simple yet far-reaching issue, and shows how modern system science has rediscovered this phenomenon. It consists of five chapters including an introduction, three chapters of the main body, a short conclusion and an important appendix depicting the system dynamics approach.

Chapter 1, which serves as the *Introduction*, describes the above-mentioned nature of collapses, underlining that "collapse is not a bug, it is a feature". In other words, from a scientific approach, one might learn to live together with collapses happily by accepting them rather than trying to fight them. Here, Bardi emphasized that collapses are ubiquitous, and all have some common characteristics, such as they occur in complex systems or networks that behave in a non-linear way. His inspiring message is that common sense may be enough, and one can cope with collapses, reduce the damage they cause, and even exploit them to their advantage.

Chapter 2 entitled *The Mother of All Collapses: The Fall of Rome* presents the fall of the Roman Empire as the collapse of a complex system. By illustrating a set of different but mutually reinforcing causes and effects, called feedbacks, that led to the relatively fast collapse of the Western Roman Empire in late antiquity, the author drew a parallel between the ancient Roman Empire and globalisation as our current empire.

Chapter 3 goes into detail of the *Collapses of Large and Small* in seven sections by examining various fields where collapses often occur. One part of this chapter deals with complex networks as a way of modelling our natural and social environment. From this point of view, the so-called "Seneca collapses" (very quick decline of complex systems) can be considered as phase transitions, when networks become completely rearranged, which are quite common. The author indicated important points about depletion in the context of natural, renewable and non-renewable resources which can easily be reflected further in social systems. Particularly, in the context of overexploitation of natural resources, the author asked whether the oscillations, disasters and suffering caused by them could be avoided or, at least, reduced in amplitude. The answer, again, lies in understanding how the laws of complex systems affect markets, and the economic and financial environment. Of course, politics and lobbying also play significant roles in the outcome of the process. The last two sections of this chapter lead to modelling issues and world models as first described by Jay Wright Forrester (MIT) and in the well-known "Limits to Growth" literature (cf. Meadows *et al.*, 1972), as well as to the issue of the collapse of the earth's ecosystem as a result of increasing CO_2 concentration.

Chapter 4, *Managing Collapse,* brings forward the question of how to avoid and/or exploit collapse, that is, how to manage and how not to mismanage complex systems. In the first section of this chapter, the question of overexploitation reappears, and several possible solutions are listed and assessed. At this point, resilience is a key term that means much more, or even the opposite, than just resisting a change as it implies adaptability to changing conditions without becoming vulnerable to outside shocks. This chapter also mentions examples for the recovering of collapsed systems which is the other side of resilience. Importantly, financial collapses and their prevention are also discussed. In the second section of Chapter 4, the exploitation of collapses is discussed by differentiating between hostile and creative collapsing, the latter being the case when a system eliminates the old and creates space for the new. It can be a managed collapse of an obsolete structure in order to facilitate a transition that needed to happen anyway. The persistence of obsolete structures can be observed in various social and economic systems, such as bureaucracy or "The Fossil Empire", therefore, many efforts are needed to "pull the levers in the right direction". Indeed, in the time of climate change, more than ever the issue of how to build resilient societies and economies is key. In this context, a noteworthy question (but not mentioned in Bardi's book)

is also how complex systems behave in spatial terms, and what factors determine the different resilience of places.

Chapter 5, serving as the *Conclusion*, repeats that everything continues to change, and that change is unavoidable. Instead of dreading it we might learn how to adapt ourselves to it.

The *Appendix: Mind-Sized World Models* retains the reader-friendly style as it provides some illustrative models to represent how complex systems, such as predator and prey populations, behave in real situations (known today as the "Lotka-Volterra" model). This part of Ugo Bardi's book proposes system dynamics as the best option for simulating complex systems in a low-cost, user-friendly and still effective way equipped with commonly available software tools. Using the system dynamics method, Bardi reproduces the Seneca curve in a relatively simple stock-flow model. In this way, we can better see real-life interactions and hence understand more about our future.

One of the most interesting points of the book is that complex systems never reach a statically stable position. Instead, they oscillate dynamically around the so-called "attractor", which is a couple of values that stabilise a system, without ever reaching it. Furthermore, when complex systems grow, their growth mechanism is non-linear. There are different kinds of non-linear models and some of them, such as the exponential, the logistic or the bell-shaped models, can be described by mathematical functions. However, the most common "Seneca model" cannot be described using an equation as several subsystems are linked to one another after reaching a certain complexity, generating feedback effects. Consequently, when a system starts to fall, the decline is much faster than the growth. Despite the lack of an equation, the above-mentioned curve can be simulated by means of system dynamics à la J.W. Forrester to illustrate the Seneca model.

It would have been good to see some references within the book to another report from the Club of Rome, namely Bernard Lietaer and co-authors' (2012) book titled *Money and Sustainability: The Missing Link*. Unfortunately, there is no reference to this report. However, Lietaer and his colleagues articulated a statement that was very close to Bardi's setting about financial collapses, when they wrote:

> This report proposes that we view the economy as an open system consisting of complex flow networks in which money circulates between and among various economic agents. It has recently become possible to measure with a single metric the sustainability of any complex flow network on the basis of its structural diversity and its interconnectivity. A key finding is that any complex flow system is sustainable if, and only if, it maintains a crucial balance between two equally essential but complementary properties: its efficiency and its resilience. When too much emphasis is put on efficiency at the cost of resilience, diversity is sacrificed. This will automatically result in sudden systemic collapses. (p. 13)

The authors illustrated their statement with a curve which resembled Bardi's curve of the Seneca effect. We would welcome to see the ideas by Lietaer and his

co-authors and by Bardi linked together in literature in the near future. However, all things considered, we found *The Seneca effect. Why growth is slow but collapse is rapid* a really engaging book that is well-illustrated, opens the readers' eyes and sheds new or more light on certain important aspects of the dynamics of humanity's natural, social, and economic environments.

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