

EDITED BY  
ÂNGELA GUIMARÃES PEREIRA  
AND SILVIO FUNTOWICZ

**SCIENCE,  
PHILOSOPHY  
AND  
SUSTAINABILITY**  
THE END OF THE  
CARTESIAN DREAM

ROUTLEDGE EXPLORATIONS  
IN SUSTAINABILITY AND GOVERNANCE

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# Science, Philosophy and Sustainability

For science to remain a legitimate and trustworthy source of knowledge, society will have to engage in collective processes of knowledge co-production, which not only include science, but also other types of knowledge. This process of change has to include a new commitment to knowledge creation and transmission and its role in a plural society.

This book proposes to consider new ways in which science can be used to sustain our planet and enrich our lives. It helps to release and reactivate social responsibility within contemporary science and technology. It reviews critically relevant cases of contemporary scientific practice within the Cartesian paradigm, relabelled as ‘innovation research’, promoted as essential for the progress and well-being of humanity, and characterised by high capital investment, centralised control of funding and quality, exclusive expertise, and a reductionism that is philosophical as well as methodological.

This is an accessible and relevant book for scholars in science and technology studies, history and philosophy of science, and science, engineering and technology ethics. Providing an array of concrete examples, it supports scientists, engineers and technical experts, as well as policy-makers and other non-technical professionals working with science and technology to redirect their approach to global problems, in a more integrative, self-reflective and humble direction.

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### **Science, Philosophy and Sustainability**

The end of the Cartesian dream

*Ângela Guimarães Pereira and Silvio Funtowicz*

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# **Science, Philosophy and Sustainability**

The end of the Cartesian dream

**Edited by Ângela Guimarães Pereira  
and Silvio Funtowicz**

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‘This inspired collection serves to awaken us from the illusory dependence on the Cartesian dream that arrogantly assumes that nature and society can be controlled. It calls for a renewed sense of responsibility in science, driving innovation to serve society in the pursuit of sustainability, justice and equality.’

Cynthia Selin, Arizona State University, USA

‘For too long, sustainability was considered a low-hanging fruit for science and technology. It appeared to require nothing but an expansion of rational control, optimized performance, more efficient resource-use. This book shows that a more humble, probing, and integrative approach is required for science and technology to genuinely promote sustainable development. Aside from defining the challenge, it provides the conceptual tools for meeting it.’

Alfred Norman, Technische Universität Darmstadt, Germany

‘The book edited by Ângela Guimarães Pereira and Silvio Funtowicz on Science, Philosophy and Sustainability, is a sign of hope. If humanity wants to address and overcome the vital challenges of global environment crisis we will need a New Organon for scientific research and scientific debate. This book is a milestone in the right path.’

Viriato Soromenho Marques, University of Lisbon, Portugal

‘The Cartesian dream of absolute scientific knowledge and absolute technological power has suffered greatly over the past decades, giving way to increasing paradox, confusion, indeterminacy and concerns over technology’s perverse effects. This outstanding collection of articles is required reading for anyone seeking to understand this philosophical, scientific, technological and social crisis.’

Tsjalling Swierstra, Maastricht University, the Netherlands

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# Foreword

*Mario Giampietro, Series Editor*

We live in a world in which the majority of people in command seem to believe that all our problems have solutions. All we need to do is throw enough money at a problem so as to provide an adequate amount of research and economic incentives. According to the accepted *mantra*, more know-how (human ingenuity) and effective institutions (invisible hands) will sooner or later fix everything. Given the large variety of problems modern society is facing, the basis and ubiquity of this conviction are difficult to explain. In fact, in addition to the historic (but yet unresolved) set of problems – war, hunger, inequity, shortage of capital, fragility of social fabric – we now also face new problems typical of the modern era, such as environmental damage, shortage of resources, terrorism, migration and progressive ageing in post-industrial society. The accelerated rate of change in activities expressed by human society represents nowadays a constant source of stress on cultural identity, religions and institutions. In this situation, even if science (human ingenuity) and institutions (invisible hands) are able to solve some problems at the local scale, it is evident that the rate at which some solutions are found cannot match the rate at which new problems emerge or old problems exacerbate. To make things more difficult, the solutions of specific problems addressed at the local scale tend to generate new problems because of the emergence of unexpected side effects not considered in the original framing of the problem to be solved. In fact a problem is a discrepancy between an expected and a perceived state of affairs. This means that an increase in both our expectations and our knowledge about the external world unavoidably results in the generation of a larger number of new problems.

Yet, in spite of a long series of failures – nuclear energy generating electricity ‘too cheap to meter’; genetically modified organisms ‘eradicating hunger from this planet’, biofuels generating ‘an abundant, cheap and environmental friendly alternative to fossil fuels’, the global scheme of tradable permits ‘reducing CO<sub>2</sub> emissions’, countries of the European Union ‘innovating their way off of the crisis’, big data generating good jobs aplenty and ‘wider social and economic benefits’ in the order of billions of euro – the ideological belief in the problem-solving power of science is unabated.

A quote may help in explaining the persistence of this intoxication. During the Second World War Kenneth Arrow served as a weather officer in the US Army Air Corps in a team producing month-ahead weather forecasts.

As Arrow and his team reviewed these predictions, they confirmed statistically that Corps' weather forecasts were no more useful than random rolls of a die. Understandably, the forecasters asked to be relieved of this seemingly futile duty. Arrow's recollection of his superiors' response was priceless: 'The commanding general is well aware that the forecasts are no good. However, he needs them for planning purposes.'<sup>1</sup>

The belief in the absolute power of both predictions and innovations has no rational basis. It is an illusion; a dream about power and control. It serves to escape the stress of decision-making created by uncertainty. The more important the decisions are, the stronger is the need to believe that we can know 'what is the best thing to do'. After the scientific revolution dissolved the universe of certainties established by religion, Western society had to adopt a new faith to legitimise the choices made by the establishment. A legitimate power structure had to claim to be able to individuate optimal solutions and strategies. According to this faith, in modern society, the established power makes decisions not just because of particular interests of lobbies or for the common good, but also because the chosen policies have been marked out as 'the best thing to do' according to the truth indicated by science, be it that this selection can be more ritual than factual.

This book, the second of the series *Routledge Explorations in Sustainability and Governance*, provides an informed reflection on these themes. The contributors represent a team of outstanding scholars who have spent a lifetime reflecting, from different angles, on the implications of the Cartesian dream in relation to the production and use of science for governance. While the first monograph of this series presented an innovative approach to quantitative assessment, this book provides a critical appraisal of the quality of the narratives used in science for governance. It does not provide *solutions* to the issue of science for governance in face of uncertainty, but it offers the fruits of reflexivity, and reflexivity is the essential ingredient to appreciate what is good and what is bad in dreams.

## Note

- 1 R.W. Fisher, 'An Economic Overview: What's Next. Remembering Carol Reed, Aesop's Fable, Kenneth Arrow and Thomas Dewey', Remarks before the Rotary Club of Dallas, 13 July 2011(<http://www.dallasfed.org/news/speeches/fisher/2011/fs110713.cfm>) accessed Aug. 2014.

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# Preface

## Descartes and the rediscovery of ignorance

*Jerome Ravetz*

Reviewing this rich collection of insights on the working out of the dream of René Descartes, we are struck by the variety of fields in which we are his intellectual children, and where we now feel the need to grow up. Descartes was a universal genius, making revolutionary contributions to mathematics, mechanics, physics and philosophy. Although he was ahead of his time, by the later seventeenth century the educated common-sense of north-western Europe was inhabiting the world that he created. Both the humanised universe of Aristotle and the magical cosmos of the alchemists were fading. The voices of divine authority and inner illumination were being stilled, in science as in society. Knowledge was to be modelled on the disenchanting mathematics of geometry, allied with disciplined sense-experience. All this harmonised with the growth of the new *possessive individualist* society, more clearly expressed by Hobbes than by Descartes. This synthesis provided mutually supportive rationales, along with opportunities for the eventual fruitful applications of the sciences (natural and social), that stemmed from Descartes's teaching.

The intervening centuries saw the growth and maturity of the modern worldview, in the theory and in the practice of both science and society. There were many complications and setbacks, and many unfinished struggles in all spheres. By the time of the age we call *Victorian*, the dream of Descartes seemed triumphant: science and progress ruled all. But it is now just a century since it began visibly to fall apart, in the collapse into the Great War. And in Cartesian science, the subversion of Descartes's dream from within has proceeded apace, first in Einstein's relativistic physics and Gödel's anti-foundational meta-mathematics, and then in the ever deepening paradoxes of quantum theory. The essays in this volume show clearly how Descartes's vision has been deeply compromised, in one area after another.

In this prologue, we should consider the question, is there some core element of the Cartesian dream that we should identify, the better to come to terms with it and move on? For this, we can go back to the beginning of his endeavour. According to his autobiography in the *Discourse on Method*, he did not initially set out confidently to recast the world of knowledge. Rather, he was seized by doubt and disillusion, and was desperate to find a way out. This doubt was not the *methodological doubt* of his meditations that have formed the fodder of philosophical investigations



ever since. It was a much more common and urgent sort of doubt: distrust of everything that his teachers had taught him at his enlightened Jesuit school. His autobiographical account starts with this declaration:

From my childhood, I have been familiar with letters; and as I was given to believe that by their help a clear and certain knowledge of all that is useful in life might be acquired, I was ardently desirous of instruction. But as soon as I had finished the entire course of study, at the close of which it is customary to be admitted into the order of the learned, I completely changed my opinion.

Immediately he describes his moment of *endarkenment*:

For I found myself involved in so many doubts and errors, that I was convinced I had advanced no farther in all my attempts at learning, than the discovery at every turn of my own ignorance.

This is amplified and explained, when he goes through the admirable humanist curriculum at his school, and proceeds to assassinate it, showing that each subject, however attractive it seems, contains within it the seeds of its own refutation. This culminates in a passage that more than any other single text, expresses the transformation of culture from the Renaissance to the modern age.

I was especially delighted with the mathematics, on account of the certitude and evidence of their reasonings; but I had not as yet a precise knowledge of their true use; and thinking that they contributed to the advancement of the mechanical arts, I was astonished that foundations, so strong and solid, should have had no loftier superstructure reared on them. On the other hand, I compared the disquisitions of the ancient moralists to very towering and magnificent palaces with no better foundation than sand and mud: they laud the virtues very highly, and exhibit them as estimable far above anything on Earth; but they give us no adequate criterion of virtue, and frequently that which they designate with so fine a name is but apathy, or pride, or despair, or parricide.

The last accusation is thought to refer to the justification of Brutus, who killed his *father* Caesar for the sake of Rome. We all know that Descartes then resolved to use geometry as the model for true and certain knowledge, setting the conceptual paradigm for the next four centuries of European thought.

In one crucial respect, I need to correct a common misconception about Descartes. The focus of scholarly inquiry on his philosophy has left the impression that his project was a rather abstracted one, starting with philosophy and extending through mathematics to physics and beyond. But Descartes was also a prophet of modern technology, sharing the magicians' desire for power over Nature but believing that in his disenchanted world it would not be too dangerous. Indeed, in a superbly optimistic passage at the end of the *Discourse* he states a vision.

For by them I perceived it to be possible to arrive at knowledge highly useful in life; and in place of the speculative philosophy usually taught in the schools, to discover a practical [knowledge], by means of which, knowing the force and action of fire, water, air the stars, the heavens, and all the other bodies that surround us, as distinctly as we know the various crafts of our artisans, we might also apply them in the same way to all the uses to which they are adapted, and thus render ourselves the masters and possessors of Nature.

Here indeed, we have the modern scientific-technical, or should I say, technocratic paradigm, stated clearly for all to see.

That is where Descartes got to, as his own vision unfolded. But if we want to find the core of his message, we need to go back to the origins. Let us look at the statement of the discovery of his ignorance. To us, that might seem quite a natural reaction; many of us have had a similar experience at some point in our education. But there are resonances there for Descartes's readers. Raised on the same humanistic learning as himself, they would have known that the discovery of one's ignorance is not an occasion for despair, but according to Socrates, the aim of all learning! But with his characteristic stylistic genius, Descartes did not waste words on his transformation of philosophy. For him, wisdom and self-knowledge were discredited goals; what he needed, and all of us ever since, is certain truth and absolute power. These were promised on the example of geometry, and although success was not immediate in coming, we are now living with the realisation of Descartes's positive dream.

The essays in this volume are all about how the dream has turned into something else, in all sorts of ways. Doubt and complexity are now an inescapable part of our discussions of science and its applications. In Descartes's own paradigm natural science, physics, the simple certainties have given way to paradox and confusion. Ignorance now sits in the middle of the equations of fundamental physics, with the names *dark matter* and *dark energy*. It is quite possible that this ignorance, like so many sorts before it, will be conquered by the advance of science. But for now and the foreseeable future, we haven't a clue.

Similarly, error and miscalculation have come to haunt the science that we are applying in the pursuit of absolute power. The misapplication of mathematics to finance nearly undid the whole monetary system, coming close to an unintended experiment of how long civilisation could survive after the cash-machines emptied. The triumphs of applied chemistry have created supergerms and super weeds that become ever more threatening. Far from being 'masters and possessors of Nature', we are coming to see ourselves as disruptors, perhaps as 'Sorcerer's Apprentices', unable to turn off this wonderful machine of invention that now threatens to destabilise or even destroy us.

It could be argued that behind all these negative outcomes lies an assumption, or paradigm, or mindset deriving from Descartes: that science can produce certain truths and absolute power, both of them secure and safe. Students go through their most formative years learning by experience that every problem has just one solution, precise to several digits. If a scientific argument has numerical

data and mathematical techniques, what could possibly be wrong? Ignorance is irrelevant, and awareness of ignorance is a bore. Uncertainty gets only limited attention from professional philosophers, and quality hardly any at all. This is not surprising. Both are quite difficult topics, involving complexity at several levels. How much easier it is to hope to tame uncertainty with mathematics, and to believe that the misuses and abuses of scientific power could be controlled just by better regulation. But our modern predicament is not to be resolved by comforting formulas. If Descartes's rejection of awareness of ignorance is an important element of our problem, then the rediscovery of ignorance, in practice and in education, is essential to its solution.

Of course, one might expect me to be making this argument. After all, Silvio and I have been concerned with uncertainty and quality, and with the social problems of scientific knowledge, for a long time now. By putting our own work in the context of the Cartesian dream, we are showing that it is not merely practical, but is also genuinely philosophical. Participating in a dialogue that goes back to Descartes and Socrates, we belong to an important tradition.

It would be unjust to Descartes for me to omit one important reservation that he made about the applications of science. In discussing the possibility of getting external support for his work, he gave a characteristically concise formula: that he could not work on projects that 'cannot be useful to some without being hurtful to others' (*Discourse*, last paragraph of Part 6). Thus, Descartes himself was not a simple Cartesian – something on which we could well reflect.

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# Abbreviations

AR4	Fourth Assessment Report
AR5	Fifth Assessment Report
BECCS	bioenergy with carbon capture and storage
CDR	carbon dioxide removal
DSGE	dynamic stochastic general equilibrium (models)
EGE	European Group of Ethics
EIDs	emerging infectious diseases
ELSA	ethical, legal and social aspects
EPA	Environment Protection Agency (of the USA)
ESSC	Earth System Science Committee
ESSP	Earth System Science Partnership
HAZMAT	hazardous materials
GAEIB	Group of Advisers on the Ethical Implications of Biotechnology
GIGO	garbage in garbage out
GMO	genetically modified organism
GP	general practitioner
ICT	information and communication technology
IHDP	International Human Dimensions Programme
IGBP	International Geosphere-Biosphere Programme
IoT	Internet of Things
IPCC	Intergovernmental Panel on Climate Change
MUS	medically unexplained symptoms
NAS	National Academy of Sciences
NASA	National Aeronautics and Space Administration
NUSAP	numeral unit spread assessment pedigree
NGO	non-governmental organisation
OTA	Office of Technology Assessment
RCP	Representative Concentration Pathway
RRI	responsible research and innovation
SARS	severe acute respiratory syndrome
SRM	solar radiation management

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STS	science and technology studies
UNCED	United Nations Conference on Environment and Development
WCRP	World Climate Research Programme
WGI, WGII, WGIII	Working Groups I, II and III respectively of the IPCC.
WHO	World Health Organization

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# Cartesian dreams

*Silvio Funtowicz and Ângela Guimarães Pereira*

## ‘Meditations’

This is, after all, just how I have always thought ideas are produced in me when I am dreaming.

(Descartes, *Meditations*)

René Descartes had dreams, and the arguments in them have been thoroughly discussed by scholars since then; but those dreams are not the dream in the title of this volume. Here we discuss instead a metaphorical dream, expressing the aspirations and expectations of his time, which Stephen Toulmin described in his *Cosmopolis* as ‘the hidden agenda of Modernity’ (Toulmin 1990).

Descartes’s optimistic vision about the role of mathematics, science and technology was shared and developed by other influential philosophers of the time, such as Galileo Galilei and Thomas Hobbes, but we decided to dedicate the volume to Descartes because he describes so vividly the hopes and expectations of the age of rationality, following many years of conflict and despair. Jerry Ravetz, in his epilogue to this book, quotes Descartes’s famous ‘masters and possessors of Nature’ paragraph in the *Discourse*, saying that ‘we have the modern scientific-technical, or should I say, technocratic paradigm, stated clearly for all to see’. Ravetz also remarks, quoting from the same text, that Descartes could not work on projects that ‘cannot be useful to some without being hurtful to others’. His conclusion is that Descartes showed reflexivity, and in this sense he ‘was not a simple Cartesian’, a judgement we could easily extend to many other protagonists of the time.

The dream that the emergent rational method and the deployment of science and science-based technology would deliver the truth (expressed in quantitative terms) and empower humanity to fulfil its destiny as masters and possessors of Nature, was a fundamental tenet of Modernity. Francis Bacon argued that ‘human knowledge and human power come to the same thing, for where the cause is not known the effect cannot be produced’ (Bacon 1620, aphorism III), and in an utopian prophecy, he lists the wonders to be expected, such as

the prolongation of life, the retardation of age, the alleviation of pain, the repairing of natural defects, the deceiving of the senses; ... of transmuting



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