

## 1

## Philosophy

*In the case of all things which have several parts and in which the totality is not, as it were, a mere heap, but the whole is something beside the parts ...*

(Aristotle n.d., 350 BCE, VIII: line 1)

### 1.1 Introduction

Fritjof Capra (1975) has, for some time, been pointing to similarities between the holistic understanding of the world supplied by Eastern philosophy and the findings of modern science. Churchman regarded the *I Ching*, with its emphasis on dynamic changes of relationship between interconnected elements, as presenting the oldest systems approach (Hammond 2003, p. 13). Boulton et al. (2015) claim Daoism, with its sense of interconnection and co-creation, as a precursor of complexity theory. This book will restrict itself to the Western intellectual tradition. It is upon Western sources that systems practitioners have, probably to their detriment, almost exclusively drawn. As with so much in this tradition, we owe the first attempts to use systems ideas to the ancient Greeks. von Bertalanffy (1971) and Prigogine (1997) cite the pre-Socratic philosopher Heraclitus as an influence. More specifically, Aristotle (n.d.) 350 BCE was the first to imply that “the whole is more than the sum of its parts.” Indeed, he reasoned, the parts only obtain their meaning in terms of the purpose of the whole. The parts of the body make sense because of the way they function to support the organism. Individuals can only find meaning in helping the state to achieve its purpose. The other great master in the Greek philosophical tradition, Plato, also found value in employing systems ideas across different domains. There is a Greek word *kybernetes* meaning the art of steersmanship. The word referred principally to the control of a vessel, but Plato (1999, pp. 230–231) used it to draw comparisons with steering the ship of state. Both uses imply regulation, which is why the name cybernetics was given to the new science of “communication and control” in the 1940s.

## 1.2 Kant

Moving forward two millennia, to the latter part of the eighteenth century, we reach Immanuel Kant. Kant is often seen as the greatest philosopher of the modern era and provided the Enlightenment with its motto: *Sapere aude!* (Dare to know!). Knowledge should be based solely on reason rather than superstition and tradition. Kant's work is significant for systems thinking for three reasons. First, he thought that science could obtain true knowledge, as it had with Newtonian physics, and he wanted to show why this was the case. He also wanted to understand the limitations of science. The second reason lies in his interest in "organicism" as a complementary approach to mechanistic thinking, especially in the study of nature. Third are his arguments about the capacity of humans to generate principles of moral conduct because, uniquely, they possess "the autonomy of the will."

In his *Critique of Pure Reason*, Kant sought to expose the shortcomings of both "rationalism" and "empiricism" as approaches to gaining knowledge. Rationalists, such as Descartes, believe that it is possible to employ cogent thinking alone to arrive at knowledge about the nature of things. In Kant's view using rational thought on its own leads to contradictions, for example, to proofs that God exists and doesn't exist. Reason has to be grounded in experience if it is to yield true knowledge. Empiricists (e.g. Locke, Berkeley, and Hume) believe that all knowledge has to be derived directly from experience through the senses. Kant thought that this was too subjective and opened the door to skepticism because our senses can easily deceive us. We need something more certain to rely on. Kant used the famous phrase: "Thoughts without content are empty, intuitions [perceptions] without concepts are blind" (quoted in Kemp 1968, p. 16).

If we are to overcome the weaknesses of rationalism and empiricism, we require, Kant says, a revolution in philosophy akin to that of Copernicus in cosmology (Kemp 1968). Instead of seeing knowledge as dependent upon our minds representing what actually exists in reality, we should see it as based upon what we perceive conforming to the nature of the mind. It is because all human minds structure the experiences they receive in a particular way that shared perceptions and knowledge are possible. This notion of mind as the creator of reality becomes clearer if we consider the latest brain research. According to Armson:

My senses receive 400 thousand million bits of data every second. My brain only deals with 2000 bits per second so I only notice a very small fraction – a half a millionth of one percent – of what I see, hear and smell. More extraordinary still is the observation that the 100 bits per second that trigger my visual perception are not enough to form any image of what is going on around me. My brain fills in the deficiency. It is hard to defend any claim to an objective view under such circumstances.

*(Armson 2011, loc. 975)*

The world does not present itself to us as already organized. The mind must play an active role for humans to experience it as they do.

In pursuing this argument, Kant requires a distinction between "phenomena," things as they appear to our senses, and "noumena," things as they actually are in themselves. Knowledge is possible because there is an inevitable correspondence between our

minds and things as they appear to us. This arises because our minds structure the sense impressions we receive in order that we can perceive them in the first place. Far from the mind being a *tabula rasa* (blank slate) upon which reality writes its script, it actually provides the framework that makes experiences possible. According to Kant, the human mind possesses “sensibility,” which delivers experiences, and “categories” which organize those experiences and provide understanding. There are two elements of sensibility, space and time, which supply the mind with perceptions. There are 12 ordering categories, which Kant derives from Aristotle’s logic, with four broad classes of quantity, quality, relation, and modality, each divided into three subclasses. Examples of the categories are “substance” and “cause.” The idea of substances with attributes and the idea of universal causation are not given to us in experience but are provided by the mind and impose order on our perceptions. Since these structural features of the mind are innate in human beings, the world appears to all people in essentially the same form. William Golding’s (1955) novel *The Inheritors* is a brilliant attempt to capture what the world might have looked like to Neanderthal people in contrast to our world. In the case of the Neanderthal mind, the sensibilities and categories are not quite fully established.

In short, we can only have the experiences we have because of our minds, and so there is a necessary correspondence between the structure of the mind and the way the world appears. Logic, mathematics, and sciences such as physics, Kant argues, also depend on the concepts of space and time and the 12 categories, and it is this that makes it possible for them to be successful and to add to our stock of knowledge. They are able to produce knowledge that is universally true. This is the case even though we can never have access to the external world that provides the things we sense, i.e. the noumena or things in themselves. We will never know about the world of noumena. We are human beings who observe the world through our senses so we can only ever know things as they appear. Scientific knowledge is only possible because it restricts itself to elucidating what the mind makes available through the senses.

We now have a reason, although admittedly a topsy-turvy one, for accepting the knowledge produced by science. But what are, for Kant, the limits of scientific knowledge? Clearly, it carries no weight in fields such as psychology or in answering metaphysical questions about the existence of God, the immortality of the soul, and free will. This is because the subject matters of psychology and metaphysics lie beyond what we can observe with our senses and so what science can explore on the basis of space and time and the categories. As Kant argued, thoughts without content are empty. We can prove anything and so are led into contradiction. That does not mean that reflection on these matters is pointless, just that in the case, for example, of seeking principles to guide human conduct, we have no choice but to venture beyond the knowledge that science can provide.

It is now possible to consider the second reason for Kant’s importance for systems thinking. At the time that he was beginning his philosophical work, the mechanistic view, insisting that all life forms had remained the same since their creation, was being questioned from an “organicist” perspective. Kant was much influenced by this thinking and agreed that it was impossible to provide a mechanical account of organic processes such as change, growth, and development. The vitality and diversity of nature seemed to require a different kind of explanation that accepted the emergence of new and more complex organisms. As he wrote: “Are we in a position to say: *Give me matter and I will*

*show you how a caterpillar can be created?*" (quoted in Mensch 2013, loc. 234). Kant was now in a dilemma because his arguments for what constituted scientific knowledge, later set out in the "Critique," only permitted mechanical explanations. There seemed to be a requirement for organicist thinking in the "life sciences" but using it meant it was impossible to attain the same certainty as in mathematics and physics.

Kant returned to this issue in earnest in his *Critique of Judgement*. In terms of scientific reasoning, he argued, it is indeed impossible to support organicism because this would take us "beyond the mechanism of blind efficient causes" (quoted in Kemp 1968, p. 114). On the other hand, using a simple example, biologists are not going to get very far in studying the human heart if they restrict themselves to the question of "how did this come about?" and ignore the question of "what is this for?" Teleological explanation employing a form of causality directed to ends, in this case the parts serving the purposes of the whole, is essential. Kant's solution is to argue that, while it cannot be fully justified, it seems to be of considerable heuristic value to assume purposiveness of this kind in nature. Organicism is essential to pursuing studies in the life sciences even if it does take us "beyond the world of sense" (Kant, quoted in Kemp 1968, p. 114). This will always be the case because of the unavoidable limitations on our thinking. Nature is just too complex to be encompassed by the human mind. Kant is here anticipating a conclusion of Checkland's (see Chapter 16) that systemicity is best seen as an epistemological device to inquire into the world rather than assumed to be a characteristic of the world. As Mensch has argued, not all of Kant's followers were quite as theoretically scrupulous:

Convinced of nature's vitality, naturalists and philosophers would make use of Kant's work as they saw fit. The most significant transformation of Kant's work concerned the use of transcendental principles themselves, since these tools for *thinking* about nature would be subsequently ascribed to nature itself.

(Mensch 2013, loc. 420)

As an aside, Mensch (2013) has argued that the organicist perspective had a major impact on Kant even in the *Critique of Pure Reason*. Alongside its job of constructing experiences, Kant thought, the mind must also integrate them. Ultimately this depends on the self, a single consciousness to which thoughts, reflections, and intuitions are related (Kemp 1968). In creating such a unity, the mind must operate according to some sort of organic logic. According to Mensch,

... like an organism, cognition functioned [for Kant] as a set of parts whose thoroughgoing connection realized unity even as the grounds of that unity preceded it. This was a different logic at work ... it was a reflexive logic according to which the unity of apperception was both cause and effect of itself, or, as Kant would put it in another context, both author of and subject to its own laws.

(Mensch 2013, loc. 374)

This is an interesting foretaste of the notion of the mind, or "psychic system," as a self-producing system that will be discovered in Luhmann's systems theory in Section 4.7.

On the subject of human behavior, and here we come to his third great contribution to systems thinking, Kant faced a problem even more severe than he had encountered with nature. According to science, the self must be subject to the laws of causality just as are all other phenomena in the realm of appearances. In order to uphold the notion of morality, however, we need to believe in the existence of free will. In the *Critique of Practical Reason*, Kant sets out his solution. As phenomena, humans are subject to causal determinism. However as “things in themselves” (noumena), beyond the reach of scientific knowledge, it is completely legitimate to regard them as possessing freedom:

We have in the world beings of but one kind whose causality is teleological, or directed to ends, and which at the same time are beings of such character that the law according to which they have to determine ends for themselves is represented by themselves as unconditioned and not dependent on anything in nature, but as necessary in itself. The being of this kind is man, but man regarded as noumenon.

(Kant, quoted in Kemp 1968, pp. 120–121)

Having demonstrated that it is possible to believe in free will, Kant argues that it is essential to do so. Although it may not be theoretically justifiable, from a practical point of view, it is necessary to believe in freedom of choice just because morality depends on it. On the basis of such “practical reason,” it then becomes possible to establish proper rules of human conduct. In order to be sure that they are acting morally rather than according to their individual desires, humans must be able to universalize their actions. Kant’s famous “categorical imperative” follows: “Act only on that maxim which you can at the same time will to be a universal law.” (This is sometimes formulated as always treating people as ends in themselves, never as means to an end.) So, for example, borrowing money without intending to pay it back fails the test because it treats the lender as a means and undermines trust and the possibility of future borrowing for other humans. It also turns out that belief in God and an immortal soul is rational from the perspective of practical reason. Only God can guarantee a fair correspondence between the virtue we display and the rewards we receive, and only immortality can provide for its delivery. Freedom, God, and immortality may not be laws of nature, but they are powerful laws of morality.

Before leaving this section, it is worth reflecting on the considerable impact Kant’s philosophy continues to have on Western culture. There are, for example, numerous speculations on what it might be like to escape the world of appearances and see “things in themselves” and various proposals as to how this might be achieved. Not all acknowledge Kant, but it is Kant’s influence that is at work. Huxley (1959) experimented with the drug mescaline to try to break through the “eliminative” function of the brain and sense organs. Castaneda sought the guidance of a Yaqui Indian, don Juan, to get beyond the *tonal*, “the organizer of the world,” and to witness the *nagual* (the Yaqui equivalent of noumena) and is warned, along the way, that:

Ordinarily, if an average man comes face to face with the *nagual* the shock would be so great that he would die.

(Castaneda 1974, p. 174)

In the science fiction film *The Arrival* (Denis Villeneuve, director, 2016), it takes mastering an alien language to allow humans to escape the tyranny of space and of time as a linear phenomenon. Adam Roberts' novel *The Thing Itself* speculates that artificial intelligence (AI) might achieve what humans can't:

And we've discovered that, once you abandon the notion of trying to *copy* human consciousness, AI is really quite easy to achieve .... You've done this? ... Sure ... A rational, sentient, intelligent consciousness, unfettered by the constraints of space and time? One that can see into the Ding an Sich [thing in itself]? .... Essentially, yes. Pretty much.

(Roberts 2015, p. 92)

Returning to the argument of the book, Kant's philosophy provided a kind of inverted justification for what mathematicians and physicists were doing in their own fields. They were gaining knowledge by learning how the human mind structures reality. It also gave a warning to scientists who sought to extend the mechanical model into the domains of the biological, human, and social domains. These warnings were rarely heeded as many sought to increase the scope of the scientific method even as far as psychology and sociology. For the moment, we shall continue to explore how later philosophers engaged with Kant's conclusions on the limitations of the human mind and how they impact on what we can know with certainty.

### 1.3 Hegel

Hegel, writing at the beginning of the nineteenth century, criticized Kant for his a-historical account of mind. For Hegel, the mind gives rise to reality but, at the same time, is itself historically conditioned. The mind is the driving force of history but has tended to externalize itself in an alienated way in which customs and institutions seem to stand above and control human action. However, during the Enlightenment, thinking has progressed to the stage where it is able to understand its true destiny. "The history of the world," Hegel wrote, "is none other than the progress of the consciousness of freedom" (quoted in Honderich 1995, p. 339). It was now possible for humans, with their common capacity for reason, to take control of history and build a truly free community to which they can all assent because it is a rational expression of their will. Thought frees itself from history and becomes capable of determining its future course. Society ceases to be alien and hostile to people because it is a reflection of their rational intentions.

In Hegel's "absolute idealism," the dualisms of mind and nature and subject and object are overcome because there is only mind and mind determines reality. The process by which mind is able to overcome its historical limitations and gain a holistic understanding of itself is called "dialectical." Comprehension of the whole, "the absolute," is gained through a systemic unfolding of partial truths in the form of a thesis, an antithesis, and a synthesis, which embraces the positive aspects of the thesis and antithesis and goes beyond them. Each movement through this cycle, with the synthesis becoming the new thesis, gradually enriches our grasp of the whole system. An example given in Honderich (1995, p. 342) is of "the customary morality of ancient Greece [as] the thesis, the

Reformation morality of individual conscience its antithesis, and the rational community [as] the synthesis of the two.”

## 1.4 Pragmatism

One way of reading the work of the pragmatist philosophers, Pierce, James, and Dewey (writing in the United States in the late nineteenth and the early twentieth century), is as a response to Kant’s concern about how to proceed in the noumenal world, beyond the sway of science as he strictly defined it. This realm is vast, embracing such matters as the behavior of organisms, the free will of humans, the purpose of social organizations, morality, esthetics, as well as all aspects of theology. The pragmatists found a clue in Kant’s very definition of pragmatic belief. He had written that “contingent belief, which yet forms the ground for the effective employment of means to certain actions, I entitle *pragmatic belief*” (quoted in Honderich 1995, p. 710). Their response was to seek a justification for belief and action in terms of its practical effectiveness. They differed among themselves, however, about the scope of this justification and about who should decide whether the standard set had been met. Pierce, the most restrictive of the three, felt that it could be used by scientists to extend their knowledge by taking predictive success as the main criterion for deciding between competing theories. James felt that the justification could be extended to the rightness of actions as judged by individuals. Dewey’s interest was in the resolution of problems, which meant knowledge was confirmed only when it was recognized by the community as being successful in transforming practice so as to overcome problems. Ormerod precisely summarizes the situation:

Pierce’s pragmatism is scientifically élitist, James’s is psychologically personalistic, Dewey’s is democratically populist.

(Ormerod 2006, p. 893)

Let us follow the thinking of James (particularly as described in Passmore 1970), who was the main popularizer of pragmatism with his 1907 book *Pragmatism: A New Name for Some Old Ways of Thinking*. James rejected, as did all the pragmatists, what Dewey called the “the spectator theory of knowledge,” which presented knowledge as a passive reflection of some external reality. To him the world had a “concatenated unity,” experienced by human beings not as divided into parts but as a “stream of consciousness.” Individuals had to impose a structure upon the wholeness of everything – upon the “blooming, buzzing confusion,” as he described a baby’s first experience of the world. The question for James, therefore, became what was the best way of using concepts to create order. Since reality is not static but in process, the pragmatic answer is to employ ideas that are effective in the long run in helping realize our goals and objectives and so bring benefits. True beliefs are those that prove useful over time as judged by the individuals concerned. James is excited about the free will his account lends to human beings. Because reality is in the making, they have the capacity to change and improve the world in which they live. “The greatest discovery of my generation,” everyone quotes him as saying, “is that a human being can alter his life by altering his attitudes of mind.” This freedom is constrained, however, because all ideas and actions are subject to an empirical reality check. If their consequences do not prove fruitful, then they will have to be abandoned.

## 1.5 Husserl and Phenomenology

Husserl is another philosopher who has had a major influence on systems thinkers. He wrote his major works on “phenomenology” in the early years of the twentieth century. The term phenomenology indicates that his interest was in phenomena, “things as they appear to our senses” (as Kant would say), rather than in speculating about any independent reality. Indeed, to develop a science of pure consciousness, which is the aim of phenomenology, it is necessary to “bracket” our “natural attitude” that things like trees and tables exist and cause our sensations. Once this is achieved, it becomes possible to go directly “to the things themselves” and begin a rigorous investigation of the common features of all acts of consciousness and of how the mind constitutes and experiences the world.

For Husserl, all conscious mental activity, whether linked to sensory perception, the imagination, or our emotions, is thinking about something. Philosophy is about uncovering how the mind addresses and gives meaning to the world through “intentionality.” In his later work, this thinking took him closer to Hegel’s philosophy (see Honderich 1995) as he became interested in the historicity of consciousness. He began to see experiences as conditioned by the traditions and social context of the time. They are part of a “life-world,” which we share with others and largely take for granted. Science itself emerges from this life-world and is dependent on it for the research it does, the evidence it collects, the experiments it conducts, and the way it interprets its results. It has, however, been losing touch with the life-world since its “mathematization,” following Galileo, and has nothing to say now about the really important issues of concern to humankind:

In our vital need ... science has nothing to say to us. It excludes in principle precisely the question which man, given over in our unhappy times to the most portentous upheavals, finds the most burning: questions about the meaning or meaninglessness of this whole human existence.

*(Husserl 1970, p. 6)*

Husserl’s attention to how individuals actually experience the everyday world was attractive to many philosophers and established a phenomenological tradition (see Bakewell 2017). His even more famous or infamous protégé, Heidegger, shaped phenomenology into an investigation of “being” and especially the mode of “being-in-the-world” in a particular social context. In his later work, Heidegger became concerned with a change in “intentionality” – in the way the mind relates to things as its objects. The proper purpose of human consciousness is to “reveal” the nature of being and the tools of phenomenology can be employed to this end. In contemporary society, however, this possibility is endangered by the advance of an “enframing” mentality. This is clearly expressed in modern technology, which presents both nature and human beings as a “standing reserve,” ready to be used for some instrumental purpose. Commenting on the relevance of this thinking to the Internet, Bakewell comments:

Later Heideggerians, notably Hubert Dreyfus, have written about the internet as the technological innovation that most clearly reveals what technology is. Its infinite connectivity promises to make the entire world store-able and available, but, in doing so, it also removes privacy and depth from things. Everything, above all ourselves, becomes a resource, precisely as Heidegger warned.

*(Bakewell 2017, p. 324)*

A particular strand of phenomenology, pioneered by Jean-Paul Sartre and Simone de Beauvoir, became known as “existentialism” and gained significant popular appeal. Sartre read the notion of “intentionality” as suggesting that the mind has immense freedom to interpret the world as it wishes. Individuals are influenced by biology and social conditioning, but they have no predefined nature. “Existence precedes essence,” and people are free to decide how to live and act. This radical freedom is frightening to many, and they reject the responsibilities it brings by taking on a ready-made role in the life-world. Sartre explored, in novels and plays as well as philosophical writings, how it is possible for individuals to escape their apparent destiny and live free of “bad faith.” Later, reacting to the Second World War and the events surrounding it, Sartre’s primary concern became how we should use our freedom. Thus began a life-long endeavor to fuse elements of phenomenology and Marxism into a practical program of action. Deciding that “truth” could only be established by looking at the world through “the eyes of the least favored” or to “those treated the most unjustly” (Bakewell 2017, p. 271), Sartre was led to support a variety of radical causes and groups and to reject the Nobel Prize in literature. Meanwhile his partner in life and in developing existentialism, Simone de Beauvoir, was using “applied existentialism” to explore the history of patriarchy and how it plays out as individual women lead their lives from birth to old age. Her great book *The Second Sex* argues that a female is not born but becomes “a woman” as she takes on the dominant male perspective and sees herself through the “male gaze.” Women need to stop seeing themselves as “objects” and assert their subjectivity. They can then confront the world as it really is for them, break out of gendered roles, and change their lives. Bakewell considers *The Second Sex* as the most influential work to emerge from the existentialist movement and as deserving of a place alongside those of Darwin, Marx, and Freud as “one of the great cultural re-evaluations of modern times” (2017, p. 216). It is difficult to argue with this conclusion. The two central notions of “applied existentialism” – of always siding with the oppressed and of liberating “slaves” from the perspective of their “masters” – made existentialism popular with anti-colonialist writers and campaigners such as Albert Memmi and Frantz Fanon. Both were championed by Sartre and de Beauvoir. Black American writers, such as Richard Wright and James Baldwin (who was also gay), turned up in Paris to absorb the doctrine of existentialism and to experience a freedom denied to them in their homeland. Another influential French existentialist, Maurice Merleau-Ponty, contributed to systems thinking in a different way. He introduced the idea of the human body, with its hands, feet, etc., as a primordial and permanent condition of experience. He also argued, following the *Gestalt* psychologists, that we make sense of the world through unified and meaningful “wholes” rather than clearly delineated individual perceptions. The wholes we construct are ever changing according to the intentionality guiding our observations.

## 1.6 Radical Constructivism

Radical constructivism may be little more than a footnote in the history of mainstream philosophy, but it has contributed significantly to the development of second-order cybernetics (see Section 6.4). It is associated primarily with the work of von Glasersfeld, who was writing in the late twentieth century. von Glasersfeld took his inspiration from the genetic epistemology of Piaget. Piaget’s theory stated that cognitive development in

children occurs as mental processes reorganize themselves as a result of the interaction between biological maturation and environmental experience. “Intelligence organizes the world by organizing itself,” he wrote (quoted in von Glasersfeld 1984, p. 5). At various stages of their development, children engage with the world and understand it differently. For von Glasersfeld (1984), this was confirmation of Kant’s argument that our minds do not reflect some external reality but construct that reality from what is provided by experience. In contradistinction to Kant, however, von Glasersfeld goes on to emphasize the considerable freedom this provides to human beings because of the extremely rich raw material that the experiential world provides. The world out there presumably imposes some boundaries on what is possible, but these are very broad. We are not governed in our thinking by immutable Kantian “categories” but only by the opportunities presented by the history of the construction process to date. In this respect, von Glasersfeld argues,

... the theory of evolution can serve as a powerful analogy: the relation between viable biological structures and their environments is, indeed, the same as the relation between viable cognitive structures and the experiential world of the thinking subject. Both *fit* – the first because natural accident has shaped them that way, the second because human intention has formed them to attain the ends they happen to attain; ends that are the explanation, prediction, or control of specific experiences.

(von Glasersfeld 1984, p. 4)

Just as the natural environment allows for many types of organism, so the experiential is forgiving of many ways of understanding and being in the world. von Glasersfeld criticizes pragmatist philosophers because they foster the temptation to seek access to an “objective” world on the basis of “effectiveness” but “effectiveness” he argues “is a judgement made within a domain of experience which itself was brought forth by an observer’s activity of distinguishing” (1990, p. 3). In radical constructivism, viability replaces truth as the key concept because, however much we push against the world “out-there,” all we can ever learn is whether the cognitive apparatus we have developed provides one *fit* among all those that might be possible. Returning to Piaget, a very young child possesses a viable cognitive structure even though it is incapable of logical or abstract thought. The child learns through physical actions and monitoring their results to construct a relatively stable world in which its needs are met. It does not gain objective knowledge about reality. The degree of cognitive freedom implied by radical constructivism leads von Glasersfeld to stress, again and again, the personal responsibility we all have for our words and deeds.

## 1.7 Conclusion

The philosophical ideas set out above are those that are of most relevance for examining the different ways of using systems ideas in management that will be considered in Part III of this book. For the moment, we pass onto other disciplinary areas and detail their impact upon the development of systems thinking. In a sense, though, the next three chapters are a continuation of the debate with Kant’s philosophy. His insistence on

Newton's mechanical model as the exemplar of knowledge in the physical sciences was not seriously challenged until the genesis of general relativity and quantum mechanics. His organicist approach to the life sciences continued to be influential until Darwin's theory of evolution provided an alternative to teleological explanations in that field. Social sciences, such as psychology and sociology, can be regarded as correctives to the notion of the "autonomy of the will" that underpins his reflections on proper human conduct.

