systems

MDPI

Article

How We Understand "Complexity" Makes a Difference: Lessons from Critical Systems Thinking and the Covid-19 Pandemic in the UK

Michael C. Jackson

Centre for Systems Studies, University of Hull, Hull HU6 7TS, UK; m.c.jackson@hull.ac.uk; Tel.: +44-7527-196400

Received: 11 November 2020; Accepted: 4 December 2020; Published: 7 December 2020

check for updates

Abstract: Many authors have sought to summarize what they regard as the key features of "complexity". Some concentrate on the complexity they see as existing in the world—on "ontological complexity". Others highlight "cognitive complexity"—the complexity they see arising from the different interpretations of the world held by observers. Others recognize the added difficulties flowing from the interactions between "ontological" and "cognitive" complexity. Using the example of the Covid-19 pandemic in the UK, and the responses to it, the purpose of this paper is to show that the way we understand complexity makes a huge difference to how we respond to crises of this type. Inadequate conceptualizations of complexity lead to poor responses that can make matters worse. Different understandings of complexity are discussed and related to strategies proposed for combatting the pandemic. It is argued that a "critical systems thinking" approach to complexity provides the most appropriate understanding of the phenomenon and, at the same time, suggests which systems methodologies are best employed by decision makers in preparing for, and responding to, such crises.

Keywords: complexity; Covid-19; critical systems thinking; systems methodologies

1. Introduction

No one doubts that we are, in today's world, entangled in complexity.

At the global level, economic, social, technological, health and ecological factors have become interconnected in unprecedented ways, and the consequences are immense. Seemingly unpredictable "black swan" events [1], like the fall of the Soviet Union, 9/11, the financial crisis, and the Covid-19 pandemic, have become more frequent and have widespread impact. On top of this, there are fewer shared values that help tame complexity by guaranteeing consensus. An Organization for Economic Co-operation and Development (OECD) report [2] begins:

> "Complexity is a core feature of most policy issues today; their components are interrelated in multiple, hard-to-define ways. Yet governments are ill-equipped to deal with complex problems."

At a more local level, decision makers, whether operating in the private, public, or voluntary sectors, are plagued by interconnectivity, volatility, and a pluralism of perspectives, and are uncertain how to act. An IBM survey [3] of more than 1500 Chief Executive Officers worldwide states that:

> "The world's private and public sector leaders believe that a rapid escalation of 'complexity' is the biggest challenge confronting them. They expect it to continue–indeed, to accelerate–in the coming years."

Despite this unanimity about the pervasiveness and increasing pace of development of complexity, there is no agreed definition of the phenomenon. In this paper, we begin by looking at some of the definitions that have been produced. A further section reviews some of the understandings of complexity that have come to the fore during the response to the Covid-19 pandemic in the UK. It is argued that different understandings inevitably produce quite different proposals for responding to the pandemic. The final section of the paper introduces the "critical systems thinking" view on the nature of complexity and argues that adopting this perspective opens up the possibility for appropriate action, in preparation and response to unexpected crises, using systems methodologies in informed combinations.

2. How Is Complexity Defined in the Literature?

The most commonly used definition of complexity found today emerged from the US Army War College in the late 1980s [4]. Problem situations are said to exhibit VUCA characteristics—volatility, uncertainty, complexity, and ambiguity. However, this definition lacks precision. In particular, do the "uncertainty" and "ambiguity" relate to a lack of understanding about what is going on in the "real-world", such that they can be corrected with more research, or do they highlight very different opinions on what is occurring and the right way forward, something that might be very difficult to overcome? It is better, therefore, to ground our review of the literature in this area by turning to a richer, philosophical discussion of the concept of "complexity". Nicholas Rescher [5] provides such an overview.

Rescher makes an important distinction between "ontological" and "cognitive" complexity. Ontological complexity is the complexity that exists in the real world. It derives from the quantity and variety of the elements of a system and the elaborateness of their interrelationships. It seems all the time to be increasing. According to Rescher, the complexity of reality is cognitively inexhaustible:

> "Reality is just too many-faceted for its cognitive domestication by us to be more than very partial". (p. 126)

The descriptions we provide of the physical world can never be complete. In the social world we are condemned to act without knowing whether what we are doing might be "totally inappropriate". Cognitive complexity, by contrast, derives from the different ways the world is viewed. This form of complexity is also increasing. In the natural sciences, our world picture is disintegrating as new speciality disciplines and interdisciplinary syntheses come to the fore. In the social sciences, the anarchy recognized and further encouraged by postmodernism prevails and a pluralism of world views makes agreement virtually impossible:

> "With complex social systems, decision making can thus become frustrated by the fact that much of the time no concrete way of achieving a generally agreed resolution can be achieved".
>
> (Rescher, p. 201)

Rescher separates ontological and cognitive complexity for analytical purposes but, in practice, sees them as intimately related. The complex minds of human beings have evolved in response to the complexity of the world and, as they have developed and explored the world, have been able to reveal more of its complexities. As Rescher puts it,

> " ... the development of our knowledge in a complex world is critically shaped and conditioned by the incidence of that world's complexity and increasingly brings it to light". (p. xv)

The nature of complexity is discussed in many different areas of research, for example, in project management [6]. For our purposes, however, it is sufficient to use Rescher's insights to illuminate the different definitions employed in complexity theory and systems thinking.

2.1. Complexity Theory

The main strands of complexity theory—chaos theory, agent-based modelling, and dissipative structures—are committed to uncovering the bases of ontological complexity.

Chaos theory [7] demonstrates that even simple nonlinear equations, for example, as used to describe weather systems, can display uncertain, complex behaviour that makes anything beyond short-term prediction impossible. However, the "chaos" that ensues is not chaos in the everyday meaning of the word. Chaos theory also reveals that, between order and complete disorder, a hidden order can appear. In this middle ground, behaviour never repeats itself but is drawn to "strange attractors" which seem to set limits to what is possible. In these circumstances, patterns can be recognized, and it becomes possible to predict the overall shape of what can happen. In meteorology, physics, and chemistry, the behaviour of systems can indeed sometimes be modelled on the basis of a small number of variables with fixed interactions. In social and ecological systems with huge numbers of elements (people in a city, species in a forest), with different and evolving characteristics, and impacted by numerous internal and external changes, it is much more difficult to discern the influence of strange attractors. Chaos theory, therefore, provides only a limited understanding of ontological complexity.

The Santa Fe Institute (SFI) sought to develop complexity theory beyond the limitations of chaos theory. Holland [8] argues that chaos theory is restricted to the study of "complex physical systems", containing elements with fixed properties, while the broader research area of "complexity theory" also embraces "complex adaptive systems", which consist of agents that are capable of learning and adapting as they interact with other agents. Much of the work of the SFI has consisted of using computational techniques to conduct "agent-based modelling" of the behaviour of complex adaptive systems. Agent-based modelling works from the bottom-up and seeks to explain the behaviour of the whole system in terms of the rules of interaction of the agents that constitute the system. SFI researchers have constructed sophisticated models based on intelligent agents and complex agent dynamics to simulate the behaviour of, among other things, traffic patterns, the internet, the stock market, forest fires, and pandemics. Nevertheless, the evidence that agent-based models can describe and explain, let alone help us manage, actual complex ecological, and social systems, is lacking. They provide some further insight into ontological complexity but fail to get to grips with cognitive complexity. Incorporating human beings in models necessitates reducing them to a range of behaviours which, in real life, they massively exceed and confound.

A more realistic appreciation of ontological complexity comes from the work on dissipative structures initiated by Prigogine [9]. Physical, biological, ecological, and social systems, he insists, are open, replete with disorder, and demonstrate irreversible change. While his "new science" of extended thermodynamics can help us understand them, their evolution produces unpredictable novelty. Boulton, Allen and Bowman [10] (p. 36) summarize the conclusions we can draw from this work about the complex world in which we live. They state that it

- Is systemic and synergistic;
- Is multiscalar;
- Has variety, diversity, variation, and fluctuations;
- Is path dependent;
- Changes episodically;
- Possesses more than one future;
- Is capable of self-organizing and self-regulating and, sometimes, giving rise to novel, emergent features.

Snowden's *Cynefin* [11] has become a popular framework used to advocate for the value of complexity thinking. It is described as a "sense-making" device which can help people arrive at a shared understanding of the complexities they face and how to respond to them. We would, therefore, expect it to take more account of cognitive complexity than the strands of complexity theory described so far. *Cynefin* identifies four "domains", having different characteristics, which demand different responses from decision makers. "Simple" domains exhibit linear cause and effect relationships which are easily identifiable and lead to predictable outcomes. Decision makers can employ best practice or simple methods to achieve good results. In "complicated" domains, cause and effect relationships can be identified but are often separated in time and space and linked in chains that are difficult to understand. Experts can be called in who can help understand the behaviour of the system of interest using approaches such as system dynamics. In "complex" domains, there are so many agents and relationships that it is impossible to trace the interactions and predict their outcomes. The innumerable cause and effect concatenations do, however, produce emergent patterns of behaviour that can be discerned in retrospect. A more experimental approach is required, opening up discussion and encouraging diversity until favourable "attractors" begin to emerge. "Chaotic" domains display no visible relationships between cause and effect, turbulence reigns and no patterns show themselves. There is no point in waiting in the hope that manageable patterns of behaviour will arise. Leaders may require a strong top-down approach to transform the context away from the chaotic domain and back to the complex, where patterns begin to emerge.

Thus far, *Cynefin* seems to be providing a useful way of distinguishing simple, complicated, complex, and chaotic ontological states. However, there is a fifth domain in the middle of the framework labelled "disorder". This is the context of "uncertainty about uncertainty". It comes into play when people disagree about the type of domain they are confronting and come into conflict with others holding alternative interpretations—for example, some seeing it as "complicated" others as "complex". *Cynefin*, it is said, can help them negotiate this cognitive complexity by providing a shared vocabulary for debating these issues. All viewpoints are to be respected and, indeed, may be more or less appropriate for different aspects of the context. This is all very well, but the failure to foreground cognitive complexity as a major determinant of the degree of complexity exhibited in the other four domains is, in my view, a weakness of *Cynefin* and contributes to its failure to recognize, for example, the value of soft systems approaches in the complex domain. The methods associated with the use of *Cynefin*, such as "SenseMaker", clearly do pay attention to cognitive complexity but this only serves to highlight the lacuna that exists between the description of complexity provided and the methods employed to address it.

There are other versions of complexity theory, usually found when the approach is applied to management, which do give serious attention to cognitive complexity. Stacey [12], for example, develops a process perspective, based on the work of Hegel, Mead, and Elias, which he calls the study of "complex responsive processes of relating". In his case, it is ontological complexity that is neglected. I will not consider these other versions here because, as I have argued at length elsewhere [13], they are more influenced by the particular sociological paradigms they favour, within which complexity theory is made to fit, than they are by mainstream complexity theory *per se*. In addition, no attempt has been made to use these different versions of complexity theory to provide a richer, overall account of the nature of complexity.

2.2. Systems Thinking

The focus here is upon applied systems approaches which, since they were first formulated, have had to struggle with both the ontological and cognitive complexity invoked by the issues they have sought to address. Since its original formulation in 1984 [14], I have frequently used the "System of Systems Methodologies" (SOSM) to trace the development of the various applied systems methodologies, and it is instructive to do so again now.

In its most recent form [13], the "ideal-type" grid of problem contexts that grounds the SOSM has two axes (see Figure 1). These axes, of "systems" and "stakeholders", represent the two major sources of complexity that systems practitioners face. The vertical axis details increasing systems complexity on a continuum through "simple", "complicated", and "complex". These distinctions mirror those used in Snowden's *Cynefin* framework. The horizontal axis presents a continuum of increasing complexity deriving from an increasing divergence of values and/or interests between stakeholders concerned with, or affected by, a problem situation. The terms "unitary", "pluralist", and "coercive" are employed. Stakeholders defined as being in a "unitary" relationship share values, beliefs, and interests. Those in a "pluralist" relationship differ in terms of values and beliefs, and conflict is present, but their basic interests are compatible. Stakeholders in "coercive" contexts have divergent interests and, if free to express them, would hold irreconcilable values and beliefs. Combining the systems and stakeholder dimensions in this way yields nine "ideal-type" problem contexts, as shown in Figure 1. It is apparent, therefore, that decision makers need to consider both "systems" and "stakeholder" complexity in any intervention. The two axes happen to correspond to Rescher's notions of ontological and cognitive complexity. There is, however, recognition of an issue neglected by Rescher. This concerns the added complexity produced when power comes into play on the stakeholder dimension. The existence of problem contexts labelled "coercive" reflects this possibility. The SOSM is richer than *Cynefin* in that it gives proper attention to cognitive complexity, along the horizontal axis, and draws attention to issues of power and coercion. What Snowden calls a "chaotic" domain will occur, according to the SOSM, when both the complexity of systems and stakeholders are exceedingly high.

STAKEHOLDERS

SYSTEMS		Unitary	Pluralist	Coercive
	Complex	Complex-Unitary	Complex-Pluralist	Complex-Coercive
	Complicated	Complicated-Unitary	Complicated-Pluralist	Complicated-Coercive
	Simple	Simple -Unitary	Simple-Pluralist	Simple-Coercive

Figure 1. An "ideal-type" grid of problem contexts.

The grid can now be used to trace the development of applied systems thinking and to highlight which aspects of complexity different systems methodologies prioritize. (For a more detailed analysis of 10 systems methodologies, see my recent book *Critical Systems Thinking and the Management of Complexity* [13].) Systems approaches such as systems engineering, system dynamics, and organizational cybernetics are orientated towards addressing matters of ontological complexity. The traditional methodology of systems engineering, one of the earliest applied systems approaches, recommends proceeding as though problem contexts are simple–unitary. Systems engineering takes it as a given that it can establish agreed objectives for the system of concern and construct a quantitative model of that system [15]. It is, therefore, best suited to what can be called "technical complexity". The aim is to design a system to achieve a predefined purpose by organizing the various components and subsystems (of machines, materials, money, and people) in the most efficient way possible. System dynamics makes complicated–unitary assumptions about problem contexts. Its concern is with "structural complexity". Structural complexity stems from the arrangement of and dynamic interrelationships between the many elements that make up a complicated system. The nature and quantity of interactions makes it difficult to understand the system's behaviour. System dynamics seeks to identify the significant variables and interactions that impact what happens and then model those interactions, on the basis of positive and negative feedback loops and lags, in order to grasp the underlying causes of system behaviour. In Senge's [16] hands, system dynamics becomes a search for fundamental "system archetypes" that operate, like strange attractors, to influence system behaviour. Organizational cybernetics [17], employing the "viable system model", was designed on the basis that problem contexts are complex–unitary. It demonstrates a primary interest in managing "organizational complexity". Organizational complexity is seen as driven both by the internal interactions of the parts and levels of a system and by the interactions between the system and its turbulent environment. The viability of the system becomes of central concern and also its ability to reconfigure itself to take advantage of new opportunities. Although all these systems approaches were initially designed with ontological complexity in mind (with the management of cognitive complexity left to the skills of the practitioner), they have over time been adjusted in ways that seek to take more account of cognitive complexity, with more or less success. This has been driven by the need to ensure that recommendations are implemented.

A somewhat later development in the history of applied systems thinking was the emergence of soft systems approaches. These approaches are primarily orientated to addressing matters of cognitive complexity. Warfield [18], for example, sets out 20 "laws of complexity", emphasizing that 70% of these result from the nature of human beings. For him, it is our cognitive limitations, dysfunctional group and organizational behaviour, differences of perception ("spreadthink"), and the conflict we engage in, that have to be overcome if we are to get to grips with complexity. The best-known soft systems approaches are Churchman's "social systems design" [19], Ackoff's "interactive planning" [20], and Checkland's "soft systems methodology" [15]. Their purpose is to manage the pluralism highlighted by the horizontal axis of the grid of problem contexts. This "people complexity", as we might call it, arises from human self-consciousness and free will, and is reflected in the quite different ways individuals and groups see and respond to the world. Soft systems approaches seek to bring about improvement by exploring different perspectives, and managing discussion and debate between stakeholders, in a manner which ensures enough agreement is obtained to enable action to be taken. It is argued that only when some agreement has been reached about "doing the right things" can other types of systems approach begin to contribute to "doing things right".

An even more recent development has seen the birth of systems methodologies, such as Ulrich's "critical systems heuristics" [21], which take seriously the existence of "coercive complexity". An important purpose of these methodologies is to contribute to fairness by guaranteeing that those who are potentially or actually disadvantaged by coercion, in organizations or society, have a say in decisions and, if necessary, by working on their behalf. Improvement can only occur, it is argued, if decision makers pay attention to the consequences of their actions for those affected, full and open participation takes place, and discrimination and disadvantage are eliminated. This type of systems approach can also be used to reveal and promote environmental concerns and the interests of future generations.

It will be clear that different systems approaches have vastly different views on the nature of complexity and, depending on the perspective they take, are conditioned to address complexity in different ways. The different viewpoints are influenced by favoured social theories but remain embedded in the systems tradition of work. In addition, as we shall see in Section 4, "critical systems thinking" has been able to turn this diversity to advantage and to harness the different systems approaches to provide a more comprehensive way of addressing the multidimensional, hypercomplexity found in the modern world.

3. Complexity and the Covid-19 Pandemic in the UK

The aim of this section is to show how different understandings of the nature of complexity have an impact when addressing a complex problem situation such as Covid-19. The information that would enable a proper investigation to take place is not yet available and I have made use of sources such as newspaper articles. The example should, therefore, be regarded as indicative only. Further, it is not meant to downplay the role of traditional science in finding solutions to the problems we face. It is through developing effective vaccines and better treatments that the disease will eventually be pacified. Nevertheless, I would argue, the example demonstrates that a richer understanding of the complexity involved, as the disease interacted with other organizational and societal factors, would have enabled better preparation and a more effective response, saving thousands of lives.

In the case of Covid-19, in the UK, a relevant simulation had taken place in 2016, based on the possibility of a flu pandemic (Exercise Cygnus [22]). The results showed that, in the event of a pandemic, there were insufficient resources in the health system to cope. Unfortunately, not enough was done to follow through on the findings. As a result, at the beginning of the outbreak, there were severe issues of "technical complexity" to address. There were National Health Service (NHS) staff shortages and a lack of hospital beds, ventilators, and personal protective equipment (PPE). Supply chains for essential equipment had not been established. Testing capacity was low. A number of microbiology/virology laboratories, necessary to develop and conduct testing, had been closed or outsourced to the private sector. There were no adequate arrangements in place for large-scale track and tracing or a workforce trained to undertake this task.

Once the outbreak began, the UK response placed significant reliance on mathematical epidemiological models [23]. However, such models struggle when there are many variables and/or transmission is not random, i.e., in situations of "organized complexity" [24]. They flounder in the face of psychological and socio-cultural factors—as was demonstrated in the Ebola epidemic in West Africa [25]. As chaos theory demonstrates, a small change in the numerical value attached to any variable in a model can have a huge impact on the outcome predicted. In the case of Covid-19, there was a lack of information on who had the disease, on processes of infection, on transmission rates, as well as about the reactions of individuals and communities to the disease and the actions taken to combat it. In these circumstances, these models cannot be of predictive value. The Imperial College model [26], which had already proven itself of little utility in relation to BSE and SARS [27], inevitably indicated widely differing infection and death rates depending upon the assumptions built in—from less than 20,000 to nearly 1.5 million deaths. Other models added to the uncertainty by producing significantly different scenarios [28]. Although the Scientific Advisory Group for Emergencies (SAGE) sought to present the Government with a "central view", and Government declared its faith in "the science", it soon became apparent that traditional science was out of its depth.

If we stick, just for the moment, to considerations of ontological complexity, it is clear that preparations for a possible pandemic and the response to it were flawed. In terms of Snowden's *Cynefin* framework, the failure consisted in treating a "chaotic" domain as though it was "complicated". In a "complicated" situation, cause–effect relationships can be difficult to trace and quantify. However, experts can succeed in understanding them and can use modelling to predict the behaviour of the system. In a "chaotic" situation, speedy and decisive action is required until the situation is transformed into one which is "complicated", and relationships can be identified. Time should not be wasted finessing the mathematics and statistics. As Taleb and Bar-Yam [29] put it in relation to the UK Government's response, "someone watching an avalanche heading their way [does not call] for complicated statistical models to see if they need to get out of the way". Establishment science encouraged delay as models were refined and argued over. Closing airports and seaports, lockdowns, rigorous testing, tracking, and tracing, all of which had been shown to be effective elsewhere in previous epidemics, were adopted slowly and, in the case of tracking and tracing, soon abandoned. Other countries looked on in amazement at the endless bickering about the efficacy of facemasks.

From a systems thinking perspective, failures to prepare sufficiently well for the "technical complexity" a pandemic might deliver could be addressed reasonably rapidly once it got underway—bed space was created in hospitals and in the new "Nightingale" units, supplies of ventilators and PPE were secured, and testing capacity was ramped up. It was much less easy to manage the "structural" and "organizational complexity" that soon became apparent. The relationships between hospitals and care homes provides an example of "structural complexity". The services they each provide have never been properly integrated. Following the mantra of "save the NHS", patients, seemingly, were emptied out of hospital back into care homes without testing, thus spreading the disease there. There was a reluctance to allow seriously ill patients from care homes into hospitals. The NHS was prioritized for PPE and testing kits. The increased role of the private sector, which had become dominant in running care homes, made things worse by hindering the application of standardized procedures. Care home staff moved between places of work. The effect of the interactions between these factors meant that a disaster ensued. What about "organizational complexity"? If this is taken seriously, attention is given to the ability of a system to respond to turbulence in its environment. The necessary "variety" [30] of response can be achieved by allowing appropriate autonomy to sub-systems. In England, decision making about public health issues was centralized (compare the discretion provided to states in Germany). The Government proceeded to issue proclamations which were met with incredulity because they did not match the reality on the ground. Local bodies, meanwhile, lacked the authority and information to launch their own initiatives in response to individual circumstances [31]. This was reinforced when a centralized "track and trace" system was introduced with little or no consultation with the public health teams of local authorities [32]. Only extremely late in the day, with the arrival of the second wave of Covid-19, did the Government change tack and encourage more local involvement in decision making and action.

If we now turn to the increasing cognitive complexity on display, and the relationship between the cognitive and ontological complexity, then the reasons why the pandemic soon got out of control are even easier to grasp. The involvement of "behavioural scientists" as members of SAGE signalled some acknowledgement of the importance of psychological and socio-cultural factors to the course of the pandemic. However, the thinking was constrained by the typical stimulus–response model that allows behavioural scientists to fit into "the science" paradigm and makes them attractive to decision makers. As in agent-based modelling, human beings are reduced to sets of manipulable elements. This did not encourage Government to regard the population as consisting of intelligent human beings who could process the information available to them and act reasonably. Information presented at the daily press conferences seemed chosen to present the Government in a good light. For example, comparison of the UK's performance against other countries was dropped when it became obvious it was worse. The trust that people had in the Government was dissipated. SAGE began by seeking to present a "central view" to the Government, believing this was better for decision makers than being exposed to a variety of different opinions. This may initially have blinded politicians to the uncertainty of science and to the availability of different options. Eventually, the uncertainty could no longer be hidden. Differences of opinion among SAGE members became obvious. "Alternative SAGE", and a myriad of other scientific specialists found their voice. Who knew that there were so many epidemiologists and health specialists in the country, hidden in different institutions? Once it was apparent that there was no such thing as "the science", the Government could no longer hide behind it. Politics entered the fray with a vengeance. The devolved administrations began to assert their independence more forcefully. There was disagreement between and within the Westminster parties about, for example, the importance to be given to health relative to the state of the economy. Local politicians began to see the pandemic in terms of a fight for resources. The media weighed in, amplifying the burgeoning set of disputes.

A good example of the interrelationship of ontological and cognitive complexity is provided by the growing awareness of the impact of inequality on which communities were most impacted by the pandemic. Statistics soon showed, to those willing to look, that the poorest, including many from black and minority ethnic groups, were being hit the hardest. This led to a search for reasons as to why this was the case. As various hypotheses were investigated, the ontological complexity unfolded further and gave rise to yet more cognitive speculation. Was it the result of genetic factors, cultural differences, lifestyle choices, jobs and working conditions, structural racism? Ontological and cognitive complexity proliferate in tandem.

4. Complexity, Critical Systems Thinking and Practice, and the Covid-19 Pandemic in the UK

This section suggests how things might have been different had the "critical systems thinking" (CST) view of complexity been employed and a "critical systems practice" (CSP) approach adopted in preparing for a possible pandemic and responding to it.

There are, in systems thinking and complexity theory, two different reactions to the hyper-complexity found in the modern world. We can understand these using Morin's [33] distinction between "restricted complexity" and "general complexity". Those who treat it as a case of restricted complexity continue to refine particular computational modelling techniques through which, they believe, they can explain complex systems. This is true of those in system dynamics who build computer simulation models of real-world system behaviour and seek to validate them scientifically. It is true of those who conduct "agent-based modelling" of complex adaptive systems, seeking to explain the behaviour of the whole in terms of the rules of interaction of the agents that constitute the system. Morin accepts that the "restricted complexity" viewpoint encourages advances in formalization, modelling, and interdisciplinary working but regards it as remaining "within the epistemology of classical science", searching for hidden laws behind the appearances. He sees the "simplifying visions" to which it gives rise as reductionist and potentially dangerous. According to Morin, it is essential to understand that we are confronted by a case of "general complexity". General complexity produces what Rittel and Webber [34] call "wicked problems", which are intractable for decision makers:

> "The planner who works with open systems is caught up in the ambiguity of their causal webs. Moreover, his would-be solutions are confounded by a still further set of dilemmas posed by the growing pluralism of the contemporary publics, whose valuation of his proposals are judged against an array of different and contradicting scales". (p. 99)

General complexity resists universal truth. All attempts to model it are partial and, therefore, the fundamental problem of general complexity "is epistemological, cognitive, paradigmatic" [33], concerned with the ways we seek to understand and manage complexity.

It is an achievement of CST, in my view, that it has embraced and developed Morin's concept of general complexity. It regards it as impossible for any systems or complexity theory approach to provide the kind of prior understanding of complex adaptive systems that would allow intervention on the basis of explanation, prediction, and control. The nature of complex adaptive systems is "unknowable" in this sense. In each case, an informed exploration of the problem situation needs to be undertaken. CST recommends using a variety of systems approaches, highlighting different aspects of complexity, and learning which are most useful, and what improvements are possible, in the particular context of intervention. Of course, this will include taking advantage of those more attuned to restricted complexity, but only with a clear appreciation of their limitations.

Putting this into practice, CSP argues that a rich appreciation of complex problem situations can be achieved by making use of the lenses provided by some well-tested "systemic perspectives". Systemic perspectives are not metaphors that are employed at random to yield a moment's insight. They are structured, interlinked sets of ideas, making up cohesive wholes. This ensures that they can be kept distinct from one another, they can provide deep interrogations of a problem situation, and can produce learning. Each must be well tested and, together, they should constitute a comprehensive set. I have derived my set [35] from Pepper's "world hypotheses" [36], and from the sociological paradigms and metaphors that have been found useful in organization theory and systems thinking. They are summaries of what Pepper refers to as "successes of cognition" and the "creative discoveries of generations", and what Lakoff and Johnson [37] identify as "experiential gestalts" that have enabled us to have coherent encounters with reality and provided for successful functioning in our physical and cultural worlds. Five systemic perspectives have demonstrated a capacity to provide significant insight into complex problem situations and appear to cover the ground—"machine", "organism", "cultural/political", "societal/environmental", and "interrelationships". Using them enables us to make suggestions about where failings are occurring and how things can be improved:

- Machine—is there an agreed goal, are the necessary parts well connected together to achieve the goal, and are the necessary components to hand or easily obtainable? The machine is judged on whether it demonstrates efficacy (is well organized to achieve its purpose) and efficiency (does so with minimum use of resources).
- Organism—is the system viable, are the sub-systems functioning well, with their own autonomy but still serving the whole, and is the whole adaptive to the environment, resilient in the face of shocks, and capable of learning? The organism is judged on whether its semi-autonomous parts are well co-ordinated and controlled, and whether the system is anti-fragile [38] in the face of its turbulent environment.
- Cultural/political—is there agreement that the system is doing the right things (effectiveness), has this been subject to challenge (not emerged from groupthink), and are there processes for dealing with conflict? This systemic perspective is not used as an exemplar. Rather, it alerts practitioners to look out for a variety of cultural and political factors that may require attention in the problem situation.
- Societal/environmental—have the interests of all stakeholders (including those of the marginalised and future generations) been considered, and have sustainability and environmental issues received sufficient attention? This systemic perspective is used to identify neglected stakeholders, discrimination, and inequality, and to argue that interventions should take into account the situation of the disadvantaged and the consequences for the environment.
- Interrelationships—can we identify chains of mutual causality in the problem situation and leverage points for bringing about change? The issues identified by the other systemic perspectives will, of course, be interrelated. Although general complexity forestalls mathematical modelling of these interrelationships, it may occasionally be possible to identify important linkages which offer leverage points for achieving improvement and/or suggest unintended consequences that might follow from proposed actions.

The different systemic perspectives provide breadth and depth to the exploration of the problem situation. Each reveals new matters worthy of attention and may provide a different explanation as to why the issues of concern have arisen. They will often provide conflicting information and explanations, and this is particularly helpful in gaining a full appreciation of the complexity involved and in supporting informed decision making. Once the complexity of the problem situation has been untangled in this way, appropriate systems methodologies can be chosen to address the most pressing aspects of complexity. For example, if the machine perspective reveals that "technical complexity" is giving rise to most of the issues, then systems engineering might be employed. If the societal/environmental perspective reveals that some stakeholders are being disadvantaged, and attending to this matter is a priority, then critical systems heuristics can usefully be put to work. A multimethodological approach is usually called for to address the multidimensional nature of "general complexity".

Very briefly, let us consider how using CST and CSP might have improved the preparation for and response to the Covid-19 pandemic. This can be done by looking through each of the "systemic perspectives" in turn. From the machine perspective it is clear that, at the beginning of the outbreak, some vital "parts" (e.g., ventilators, PPE) were missing and certain essential processes were inadequately planned (e.g., track and trace). A systems engineering analysis would have highlighted the issues. Peering through the organism lens would have demonstrated that the issue of what should be done centrally and what locally, in the NHS, had not been resolved. A study using the "viable system model", as part of organizational cybernetics, would have suggested the appropriate level of decentralization to employ to ensure flexible local responses while maintaining overall co-ordination. The cultural/political perspective draws attention to the "epistemological, cognitive, and paradigmatic" factors that Morin warns about. In the Covid-19 pandemic in the UK, once these had asserted themselves, it seems that what was the right thing to do simply became a matter of political debate. While this is in large part appropriate, that debate could have been enhanced using soft systems approaches. Churchman's method of dialectical debate could have unearthed possible "groupthink" in SAGE, questioned the culture of English exceptionalism (e.g., the need to develop our own "world-beating" app and track and trace system), and interrogated why the boundaries drawn gave priority to the NHS at the expense of care homes. Use of Checkland's soft systems methodology could have helped clarify the assumptions underpinning possible strategies and helped work through their implications. Viewing the impact of a pandemic through the societal/environmental perspective, decision makers would be compelled to consider whether it might fall hardest on those most disadvantaged and give thought to what might mitigate such an outcome. In the UK, such matters seem to have come as a surprise. Employing critical systems heuristics at an early stage would have proved insightful. The interrelationships perspective might have brought, for example, a more detailed understanding of the effect prioritizing Covid-19 patients would have on the treatment of heart disease and cancer. Such unintended consequences continue to occur and can, perhaps, be better anticipated using system dynamics. Bensley [4] mentions patterns of workplace engagement, the positive ecological indicators resulting from less travel, and less mortality from flu because of the use of facemasks and social distancing.

5. Conclusions

Some sympathy must be extended to the decision makers caught in the maelstrom of the Covid-19 pandemic—even if they played a part in creating the problems that arose. The system was in crisis from all perspectives. Everything seemed to be wrong and there were no obvious leverage points to be found that could be used to achieve rapid, overall improvement. Nevertheless, I have argued that, if the decision makers had been equipped with CST's understanding of general complexity and the multiperspectival and multimethodological approach of CSP, they could have fared better. It is worth reiterating some of the strengths of the recommended approach. Each systemic perspective reveals new matters worthy of attention. The different perspectives can provide alternative explanations as to why issues arise. Even when they provide conflicting information and explanations, this can prove helpful in gaining a richer appreciation of the complexity involved. They also point to informed ways forward, using a variety of systems methodologies in combination.

Funding: This research received no external funding.

Conflicts of Interest: The author declares no conflict of interest.

References

1. Taleb, N.N. *The Black Swan: The Impact of the Highly Improbable*; Random House: New York, NY, USA, 2007.
2. OECD. *Systems Approaches to Public Sector Challenges: Working with Change*; OECD Publishing: Paris, France, 2017.
3. IBM. *Capitalizing on Complexity: Insights from the Global Chief Executive Officer Study*; IBM: New York, NY, USA, 2010.
4. Bensley, J. COVID-19: A Salutary Experience of VUCA. ICCPM Newsletter. 2020. Available online: https://blogs.qut.edu.au/qutex/author/bensleyj (accessed on 5 December 2020).
5. Rescher, N. *Complexity: A Philosophical Overview*; Routledge: London, UK; New York, NY, USA, 2019.
6. Remington, K.; Pollack, J. *Tools for Complex Projects*; Gower: Aldershot, UK, 2007.
7. Gleick, J. *Chaos: The Making of a New Science*; Abacus: London, UK, 1987.
8. Holland, J.H. *Complexity: A Very Short Introduction*; Oxford University Press: Oxford, UK, 2014.
9. Prigogine, I. *The End of Certainty; Time, Chaos and the New Laws of Nature*; The Free Press: New York, NY, USA, 1997.
10. Boulton, J.; Allen, P.; Bowman, C. *Embracing Complexity: Strategic Perspectives for an Age of Turbulence*; Oxford University Press: Oxford, UK, 2015.
11. Snowden, D.J.; Boone, M.E. A leader's framework for decision making. *Harv. Bus. Rev.* **2007**, *85*, 69–76.

12. Stacey, R.D.; Griffin, D.; Shaw, P. *Complexity and Management: Fad or Radical Challenge to Systems Thinking*; Routledge: London, UK, 2000.
13. Jackson, M.C. *Critical Systems Thinking and the Management of Complexity*; Wiley: Chichester, UK, 2019.
14. Jackson, M.C.; Keys, P. Towards a system of systems methodologies. *J. Oper. Res. Soc.* **1984**, *35*, 473–486. [CrossRef]
15. Checkland, P.B. *Systems Thinking, Systems Practice*; Wiley: Chichester, UK, 1981.
16. Senge, P. *The Fifth Discipline*; Random House: London, UK, 1990.
17. Beer, S. *Brain of the Firm*; Allen Lane: London, UK, 1972.
18. Warfield, J.N. *Understanding Complexity: Thought and Behavior*; AJAR Publishing: Washington, DC, USA, 2002.
19. Churchman, C.W. *The Design of Inquiring Systems*; Basic Books: New York, NY, USA, 1971.
20. Ackoff, R.L. *Ackoff's Best*; Wiley: New York, NY, USA, 1999.
21. Ulrich, W. *Critical Heuristics of Social Planning*; Haupt: Bern, Switzerland, 1983.
22. Exercise Cygnus Report. *Tier One Command Post Exercise Pandemic Influenza*; Public Health England: London, UK, 2016.
23. Adam, D. Special report: The simulations driving the world's response to COVID-19. *Nature* **2020**, *580*, 316. [CrossRef] [PubMed]
24. Weaver, W. Science and complexity. *Am. Sci.* **1948**, *36*, 536–544. [PubMed]
25. Pruyt, E.; Auping, W.L.; Kwakkel, J.H. Ebola in West Africa: Model-based exploration of social psychological effects and interventions. *Syst. Res. Behav. Sci.* **2015**, *32*, 2–14. [CrossRef]
26. Czyzewski, A. Modelling an unprecedented pandemic. In *The Forum*; Imperial College: London, UK, 2020.
27. Steerpike. Six questions that Neil Ferguson should be asked. *The Spectator*, 16 April 2020.
28. Panovska-Griffiths, J. Coronovirus: We've had 'Imperial', 'Oxford' and many more models—But none can have all the answers. *The Conversation*, 3 April 2020.
29. Taleb, N.N.; Bar-Yam, Y. The UK's coronavirus strategy may sound scientific. It isn't. *The Guardian*, 25 March 2020.
30. Ashby, W.R. *An Introduction to Cybernetics*; Methuen: London, UK, 1956.
31. Harris, J. The pandemic has exposed the failings of Britain's centralized state. *The Guardian*, 25 May 2020.
32. McCoy, D. Countries from Germany to Vietnam got test and trace right, so why didn't England? *The Guardian*, 16 June 2020.
33. Morin, E. Restricted Complexity, General Complexity. In Proceedings of the Colloquium 'Intelligence de la complexité: Épistémologie et pragmatique', Cerisy-La-Salle, France, 26 June 2005. Translated from French by Carlos Gershenson.
34. Rittel, H.W.J.; Webber, M.M. Dilemmas in a general theory of planning. In *Systems Thinking*; Emery, F.E., Ed.; Penguin: Harmondsworth, UK, 1981; Volume 2, pp. 81–102.
35. Jackson, M.C. Critical systems practice 1: Explore—starting a multi-methodological intervention. *Syst. Res. Behav. Sci.* **2020**, *37*. [CrossRef]
36. Pepper, S.C. *World Hypotheses*; University of California Press: Berkeley, CA, USA; Los Angeles, CA, USA, 1942.
37. Lakoff, G.; Johnson, M. *Metaphors We Live By*; University of Chicago Press: Chicago, IL, USA, 1980.
38. Taleb, N.N. *Antifragile: How to Live in a World We Don't Understand*; Allen Lane: London, UK, 2013.

Publisher's Note: MDPI stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.

© 2020 by the author. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (http://creativecommons.org/licenses/by/4.0/).