

Systems and Futures

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A Converging Mutual Relevance

When systems thinking and systems methods are applied in practice it is usually with an intention to change something. This might be with the aim of incrementally improving performance to radical restructuring of the system of interest. This focus of interest may be framed narrowly as a specific mechanism or technology (like a manufacturing system) or widely as the transformation of a complex socio-technical system (like adapting to climate change). The implication of this use of systems thinking implies some kind of desired change over time; indeed ‘behaviour over time’ is a key concept in methods like system dynamics which can be used to simulate future behaviour according to different models of systems structure. However, historically this aspect of bringing about a new state in the future has generally not incorporated futures thinking methods.

Conversely, future thinking (often referred to in the literature as future studies) focusses on conjectures about a state of affairs at some point in the future for which there cannot be directly measurable evidence. Depending on the kind of situation under consideration these conjectures may be predictive based on extrapolation of known trends (as in economic forecasting), or they may be from simulations with known data input but output unknown until after simulation (as in climate change modelling), or they may be imaginative based on creative thinking and design (as in strategic foresight). The application of systems thinking in this field has been scarce.

However, there is increasing evidence that these two broad areas are interacting with each other and leading to some mutual enrichment. The context for this trend is that developing and applying policy and strategy in complex changing environments demands a wider range of perspectives and disciplines; even the broad cross-disciplinary areas that systems thinking embraces is not enough. Taken in its broadest sense, ‘systems thinking’ includes a very wide range of concepts, theories, methodologies and methods [1]. Similarly, there is a wide range of concepts and methods used in future studies [2]. Two complementary perspectives are considered. The first is where systems thinking is taking place in a context of futures thinking. The second is where future thinking is taking place in a context of systems thinking.

Application of Systems in Futures

Future thinking naturally makes assumptions about time. In a comprehensive review of scenario techniques, Bishop et al [3] refer to time in a variety of ways. For example

- the future is uncertain so we must prepare for multiple, plausible futures
- we must consider timescale: long-term versus short-term
- we can do time series analysis with systems models
- we can do multiple time series with divergences mapping
- we can estimate the timing of impact of key events

Each of these aspects of futures thinking offers a different possibility for extending the relevance of systems thinking.

Prominent in relating futures to systems thinking is the work of Ackoff [4] on the theme of redesigning the future. In the planning field he developed an integrative method called interactive planning [5]. He also worked with large corporations in advancing the way they think about beyond anticipating the future to creating it [6]. The viable system model, VSM, developed by Beer [7,8]. Espinosa and Walker, [9] particularly emphasises the importance of a systemic viability function concerned with the wider environment and the looking to the future to ensure capacity to adapt to a changing environment. This function in the VSM is designated as System 4 concerned with the “out there and future”.

Two major applications of systems thinking in futures work are causal loop modelling and system dynamics. The former is the use of causal loop structures to bring out the differentiated underlying structure of each scenario in a set [10]. The latter is the use of systems models which themselves can generate alternative scenario outcomes depending on how the key inputs to the model are set. A well-developed form of this is the creation of micro-worlds. Bunn and Larsen [11] describe a group of Shell executives developing an oil simulation game in which the players are challenged to run oil companies in the context of different global scenarios. This has emerged in the thirty year review of the Limits to Growth system dynamics modelling [12]. Soft systems methodology has also been applied in scenario work [13].

Winch [14] has used system dynamics to assist a form of dynamic provisioning for dynamic environments. This uses the stock-flow diagramming approach of system dynamics to capture the basic variables and relationships in the area of interest. He claims the strength of this approach is that it provides a way to investigate the stability of, and the transitions between, the individual snapshots of the future utilised in other scenario techniques. In reviewing the whole field of futures studies looking for evolutionary trends, Kuosa [15] incorporates aspects of systems thinking into his schema. However, he limits his interpretation to the modelling of dynamical systems arising from an engineering orientation. Systems thinking in broader sociological and policy areas, however, has threads of convergence towards futures thinking introducing the importance of choices about values and boundaries as shown in Figure 31.1.

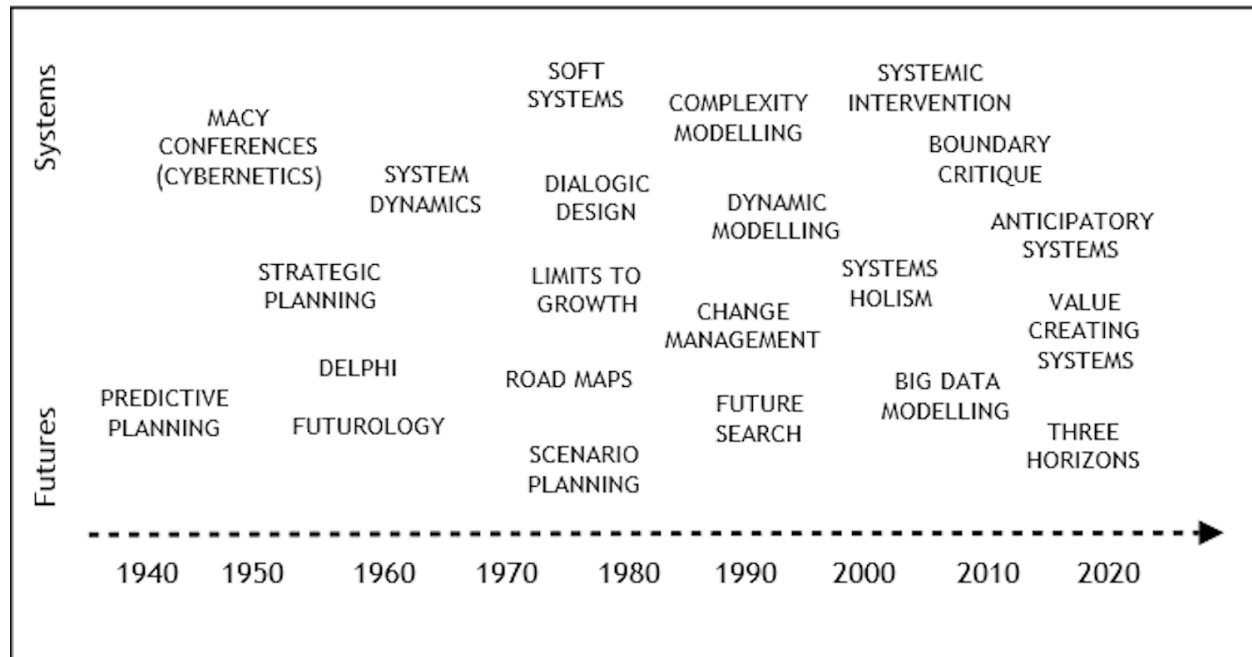


Figure 31.1 – Emergence of Futures and Systems – A Sketch.

A pioneer in relating consciousness and perception to rigorous analysis in the development of futures scenarios was Pierre Wack. Burt [16] has re-examined what Pierre Wack referred to as “the gentle art of re-perceiving”. Burt makes the point that the role of scenarios is to help managers gain a fresh perspective about the interplay between factors, actors and variables in the business environment. Assumptions are challenged by exposing new and previously unrecognised driving forces. The idea is for the scenario process to stimulate new understandings which challenge the legitimacy of existing assumptions. In reviewing the evolution of scenario methods, Burt includes the development of simulation and dynamic modelling to explain systemic structures in scenarios and refers to the introduction of feedback loops, behaviour over time graphs and influence diagrams to describe these dynamic structures, also referencing Hodgson and Sharpe [17].

The Application of Futures in Systems

There are two basic ways in which futures thinking shows up in the context of systems thinking and systems modelling. The first is where simulation modelling is used to explore possible future states of the contextual system. These are generated by different values of the system variables operating in different dynamic causal relationships over different time periods. This approach is basically in the context of quantitative or “hard” systems thinking. The second is where systemic methodology is applied to generate some kind of improvement, which is implicitly referencing a future state of the system or situation. This approach is basically in the context of “soft” systems thinking [18] and systemic intervention [19]. Morecroft [20] describes a good example of the first type using system dynamics modelling of stocks and flows to create a simulation tool.

The generic development of this application of system dynamics has come to be called microworlds (see reference). The term, originated by Papert, is used for software simulation and used extensively in

education. Warren [21] develops an extensive application of system dynamics modelling of resources to the construction of strategic architecture and strategy development. He points out that by modelling scenario generating structures it is possible to gain insights into the scale and pace of change in industry evolution. This is something that the more static "images of the future" type of scenarios cannot deal with. Sterman [22] treats modelling as embedded in a cycle of learning in which an important role is played by rehearsal of the future as in flight simulators. The basic notion here is that, with systems modelling, strategic thinkers can rehearse future possibilities to challenge the integrity of their strategic ideas and plans.

Soft systems methodology (SSM) is an example of the second more qualitative or 'soft' kind mentioned above. Checkland and Scholes ([18], Figure A, pA9) describe a cyclical process in which the emphasis is not on the model per se but on multiple models of purposeful activity which lead to an accommodation between different interested parties that can then promote action to improve, which in turn feeds into the perceived real-world problem situation. Although there is no explicit discussion of futures or scenarios, it is clear that any action to improve is purposefully directed towards a future situation embedded in a 'rich picture' of the current situation in the sense of a "make happen" rather than a "might happen". This approach is also illustrated by Bustard et al [23] in engineering. They begin from the idea of improving a business using SSM as a means to develop a vision. This is combined with a technique called use-case modelling. The term 'scenarios' is used in a rather restricted engineering sense of 'event action sequences' that describe possible system behaviour.

Some references to futures thinking occur also in approaches to systemic resilience. Wright et al [24] use SSM concepts to consider a range of root definitions for resilient systems. For example: "A system to identify possible hazards, disruption and stress by imagining and developing scenarios of what may happen or be achieved and assembling this intelligence together with intelligence about historical events and lessons learned and storing, processing and making available this information as required." ([24], p49).

In some systemic interventions using problem structuring methods use has been made of a rich picture approach to depict possible futures beyond the current problematic situation [25]. A recent development by Scolozzi and Poli [26] is to extend the frame of system dynamics to include anticipation thus linking it with Rosen's [27] anticipatory systems ideas incorporating the idea that future states may determine present changes of state. Maier [28] proposes that "identification of "best-guess" future conditions might no longer be appropriate. Instead, multiple plausible futures need to be considered, The trend to combine futures methods with systems thinking is illustrated by the work of Smith et al [29]. "A participatory workshop and interviews, using a combination of systems thinking and futures techniques, revealed a shared goal of sustainable livelihoods, which provides an integrated and systemic focus for coastal adaptation strategies." More complex ways of framing the landscape of futures methodology are described in the analysis used by Aaltonen and Barth [30] Figure 31.2.

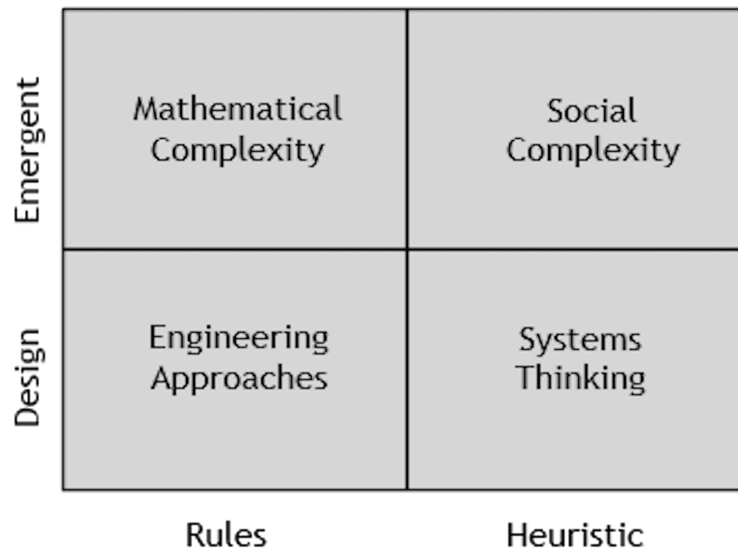


Figure 31.2 – Framework of futures analysis that includes systems thinking (Aaltonen and Barth).

“The picture identifies four distinct types of landscapes, two of which – engineering approaches and systems thinking – have a long history, are widely used, and currently dominate thinking and practice in strategic management. The other two – mathematical complexity and social complexity – are not yet widely used, and they represent both a contrasting and a complementary view of how the future emerges.”

Taking it Further - Anticipatory Systems

It is in the domain of strategic thinking that systems and futures come together most strongly. Any strategic decision has to take into account present and future structures and environments in which an enterprise will be developing. The present structural aspect can be analysed with the varieties of systems thinking applied for example in scenario planning. But also any strategic decision has to take into account the future structural discontinuities and uncertainties that have little in the way of evidence or precedence to rely on. Imagination must also play a part. The same applies to the domain of governance and policy in that both systems thinking and futures thinking need to be integrated in a field called anticipatory governance [31]. Anticipation is a concept that can link systems and futures more powerfully than techniques of scenario planning alone.

A substantial challenge for anticipatory thinking in the service of decision making is that we are used to shaping decisions analytically on existing evidence whereas rapid foresight requires thinking beyond the evidence. Foresight is rarely strongly coupled with decision [32]. However, if decision and foresight are cybernetically integrated, meaning there is a mutual influence, this can set up a different kind of system, an *anticipatory system* [27,33]. From a conventional decision making perspective, our interest in the future is to anticipate sufficiently taking advantage of opportunities and being better able to avoid threats. Anticipatory systems go beyond foresight and futures studies and also beyond the usual decision making processes. [31,34]. The idea of anticipatory systems emerged from considering the nature of life in

biological systems. So what is the idea of an anticipatory system and how is it different from a normal system?

An anticipatory system has built in a particular kind of modelling function which is able to carry out time path mapping faster than the unfolding of 'real' time events. [35]. It is generating the kind of information you would get if the 'future was already here'. The impact on the behaviour of the system of this output is not to be confused with feedback. Feedback is information from the past about a deviation from a set norm. In contrast, information from anticipated future states is essentially a *feedforward* process. This feedforward capability is also implicit in the Conant Ashby principle that any regulator of a viable system needs to incorporate a model of its own system and its environment. [36]. Anticipation implies, therefore, deciding what to do now in this present moment in terms of what is perceived to be the consequence of that action at some later time than the immediate now [35] where circumstances are radically changed. To present understanding this action may seem incongruent, even irrational. Anticipation under turbulence requires the system to have the capacity to imagine and model the world in such a way that the estimate of future changes is convincing and powerful enough for the decision maker to commit to action that may seem incongruent or even imprudent until the passage of time reveals otherwise. This can be seen in the 'foolhardiness' of entrepreneurs taking 'the impossible' path to success.

First-order decision analysis leaves out the decision maker in order to be 'objective'. This presents a problem since the basis of futures thinking is entertaining that which has not yet happened and which cannot be predicted by simple extrapolation. To include the mind of the decision maker in an approach to anticipatory systems we must move to a second-order perspective [37]. Since anticipation incorporates the capacity to act in accord with, as well as perceive, the future (or some representation of it) then, from a second-order perspective, the state mind of the decision maker is a key factor in the functioning of a human anticipatory system.

From First-order to Second-order Anticipatory Systems

Poli, in his review of the many forms of anticipation [33] points out a fundamental issue is considering the nature of systems which have built in some way of anticipating the future. 'The future' has to be 'made use of'. As a decision making system how are we aware of the future? To accommodate this question Rosen's definition needs expanding in a way that offers the possibility of integration with the phenomenology of the present moment [38]. Rosen's idea that an anticipatory system is one which contains an internal predictive model of itself and its environment goes beyond a reactive system based solely on feedback from what has already taken place. Reactive systems can only respond to changes that have already happened and for effectiveness depend on a reasonably regular repeating environment. In contrast an anticipatory system not only responds this way but is in addition continually sense-making taking into account futures that have not yet happened.

Figure 31.3 presents an extended version of Rosen's anticipatory system. In the diagram, S stands for system, which may be an individual organism, an ecosystem, or a social or economic system. At first view, S is an ordinary non-anticipatory dynamical system. M represents a model of S. In Rosen's account [27] the behaviour of S is considered to be taking place in conventional real time. The behaviour of M, however, is taking place in a time variable which goes faster than real time. This means that after a fixed

interval T then M will have proceeded further along its behavioural trajectory than S . In this way, the behaviour of M predicts the behaviour of S ; by looking at this stage of M at time T_1 we get information about the stages that S will be in at time T_2 . M and S are set up to interact in specific ways. Suppose system M is equipped with a set E of effectors which allow it to operate either on S itself or on the environmental inputs to S , in such a way as to change the dynamical properties of S . The whole system will now be adaptive such that prospective future behaviours determine present changes of state. Anticipation would require the further property that M can discriminate between desirable and undesirable states and can change the dynamics of S in a way to avoid the undesirable region as well as cope with mutual possible trajectories in the future.

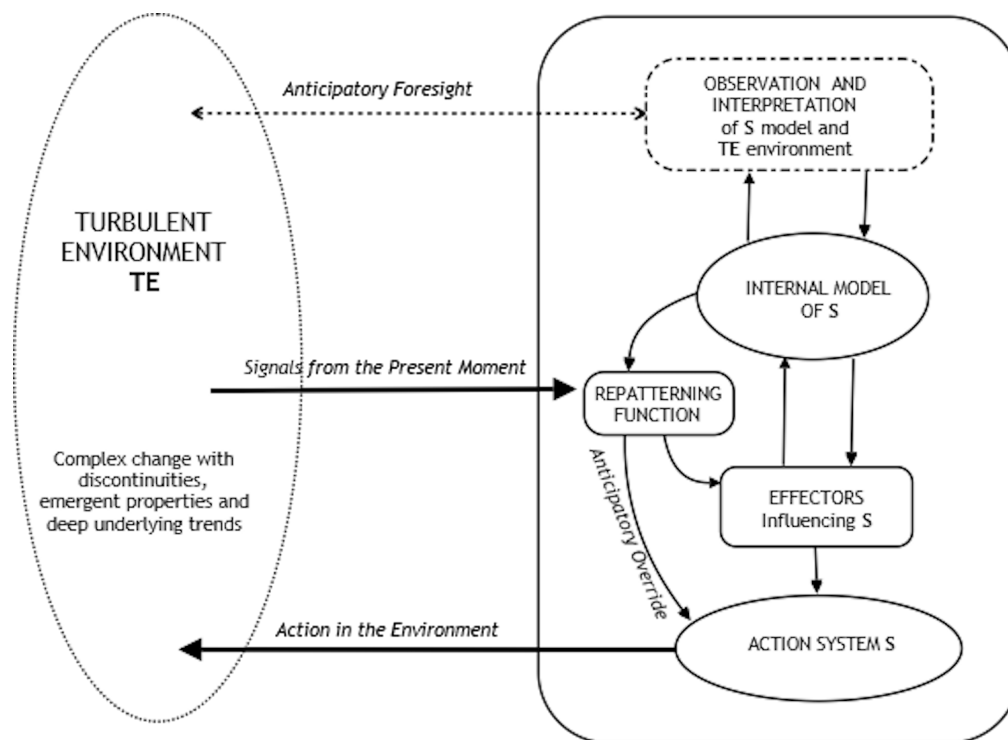


Figure 31.3 – Second-order Extension of Rosen’s Anticipatory System Model.

If S is a planning system then we can make further propositions from this model. To be anticipatory beyond adaptability, the system needs to be open to interactions that enable M to be revised and extended beyond inherited experience (feedback) and the system needs M to be able to reframe and re-perceive its advance running in the light of an anomalous situation that is not yet experienced (feedforward). There is also the question as to whether, without openness to information from the future and in some sense ‘guessing futures’ the system is fully anticipatory in an impredicative world in which time may be richer than simply a linear ‘block time’ future.

A second-order anticipatory system therefore includes the observer in the system. However, since anticipation implies action based on perception of the future the observer is also the decision maker, exercising choice amongst possible pathways. The span of awareness of the decision maker determines a ‘present moment’ in which past, present and future information is simultaneously included. The present

moment of the decision maker can be richer and more complex than simply an instant in time, and can be related to the time span of consciousness [39,40]. Phenomenologically an experienced presence of the past is referred to as *retention*, which is distinguished from memory. The experienced presence of the future is referred to as *protention*, which is distinguished from fantasy. The span between these two is the *duration* as the decision maker's active felt sense of time.

To sum up, a second-order development of the anticipatory system includes as part of the system an observer-decider who is able to reflect and act on the consequence of anticipatory model assumptions. This opens up the possibility of creativity and acausal factors entering into the decisions rendering them better able to fit with the unfolding future.

Synthesis in Strategy

The areas where systems and futures strongly come together are in strategic planning and in complex design. In fact these two areas increasingly overlap in tackling 'wicked' systemic problems. For example considerations of design, architecture and urban systems all come together in economic development. Mixed discipline teams come together to develop a shared understanding of highly complex sociotechnical problems. This involves systems mapping as well as the use of visual representation methods and modelling. Complex projects develop over time and reveal emergent properties. To the extent that some of these can be anticipated this improves capacity for decisions guiding the process. Scenario planning methods have been incorporated in an approach to an integrated operational framework for resilience [41]. Three horizons have been used to map the shifting systemic patterns over time, especially through changes with more discontinuity, for example developing strategy for digital governance [42]. There is a different dominant system in each of the three horizons as in Figure 31.4.

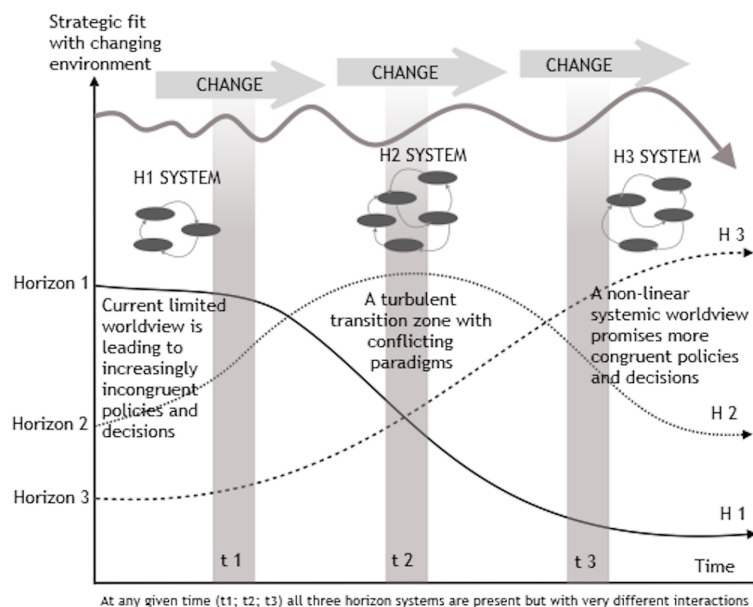


Figure 31.4 - Systems thinking integrated with Three Horizons futures thinking.

A form of strategic systems thinking closely linked with futures is value creating systems, VCS. This is a socio-ecological approach with roots in systems theory; it also draws on thinking from open systems and actor network systems as well as scenario planning methods [43]. Some of the key notions integrated into VCS thinking are systems of co-production rather than value chains; multiple patterns of interaction not just restricted to money and the dynamics of increasing returns. VCS design requires careful consideration of the fittingness with the environment. In current situations of uncertainty and turbulence scenario planning is used to explore the boundary conditions between the system and the uncertain environment by creating multiple roadmaps corresponding to multiple scenarios of the future [44,45].

Conclusion

The comparative review of the overlaps between boundaries, systems and futures indicates a trend to recognise that there are common aspects as well as distinct aspects in systems thinking and futures thinking. This is not surprising in so far as both have a regard for the underlying structure of the conditions they are dealing with and both are in some way developing contexts to support decision making. The crucial distinction is that systems modelling works with evidence from the present and past whereas futures thinking, in the absence of evidence from the future, must work with conjecture and imagination. The question is, what value might there be in considering how the two fields might be more directly synthesised in a second-order framing?

The survey of links between systems and futures, coupled with my own reflections on years of practice in the field of strategy development in corporations, public sector and third sector organisations, [46] lead to three propositions that need underpin any integration. Some limitations that could be overcome are:

1. Systems thinking without scenarios thinking tends to be ‘future blind’ and deeply constrained by present evidence.
2. Scenario thinking without a systems context tends to be haphazard and unconsciously conditioned by entrenched beliefs.
3. We need a new integrated framework to serve as a base for changing our understanding of systems and futures as being contiguous considerations of the same reality.

A synthesis could make a positive contribution to the way decisions about policy and strategy are supported in an increasingly turbulent world. A synthesis could better frame the nature and methodology of decision making with systems-based and futures-based strategy work in business, governance and community resilience by creating emergent properties of insight which could not be achieved by the disciplines in isolation. Some of the key underpinning propositions to build this synthesis on are:

- a) Essentially any scenario depiction of a future situation configures that situation. These attempt to describe *what it is like then*.
- b) A scenario set may be in the form of narratives in which there is an articulation of the temporarily parallel story lines. These attempt to describe qualitatively *how we got from now to then*.
- c) A scenario may be a set of statistics of key parameters (economic growth, price of oil, proportion of consumer spending and so on). These attempt to describe *how ‘then’ is quantitatively performing*.

- d) Systems thinking can provide an additional discipline to create plausible models of the various depictions to emphasise that *scenarios are dynamic narratives* that unfold over time, not simply static snapshots of a future.
- e) The very implication of behaviour over time implies *attention to a possible future state* indicated by combining imaginative and computational simulation.
- f) The very notion of intervention is second order and implies that there is an agent who is in some way interfering with the system in question. This may be benign (like a cure for an ailment) or disruptive (like a technological displacement).
- g) Systemic intervention also implies a concern with, in some meaning of the word, *improvement* [19] implying a value position. In being second-order it is also inseparable from ethics [47]. Improvement also implies that at some point in the future a situation or system will be in a better state than it is at present. It is a concept with a future embedded in it.

Overall, appropriate synthesis of systems thinking and futures techniques could develop a new discipline of anticipatory practice which is seriously needed as we increasingly confront our current human inability to make restorative and regenerative headway in face of the major complex and unavoidable global issues affecting us all.

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