Chapter 7
In Anticipation of Black Swans

Raul Espejo

Abstract Problematic situations are recurrent in organisational systems. We are all, individually or collectively, managing them and need strategies for this purpose. Indeed, for as long as we maintain interactions with others we are managing problematic situations; sometimes we simplify them too much yet in others we respond chaotically without proper reflexion; in either case the cost of these responses to people and organisations can be too high. In this paper I reflect upon a third strategy aided by Ashby's Law of Requisite Variety and complexity theory. The law gives insights to manage environmental and organisational complexities and complexity theory gives insights about environmental constraints and the emergence of self-organisation. Together they provide a view of organisational systems and most significantly, of how to improve the management of extreme situations -*black swans*-, such as wars, catastrophes, social unrest, extremism, and multiple other expressions of very high variety situations.

Keywords Requisite variety • Complexity theory • Constraint • Black swans • Self-organisation

7.1 Pareto's 80/20 Rule

In Heart of Enterprise Beer (Beer 1979, p. 15) gives the example of the reorganisation of the railways in England in the 1960s. He uses Pareto's 80/20 rule (see Fig. 7.1). A revision of the railways profitability roughly confirmed that 20% of the tracks were responsible for 80% of the pay-offs and, management assumed that by focusing on this most profitable 20% the railways performance could significantly improve. Proposals were made for closing down the inefficient tracks. However, this restructuring did not anticipate that closing the 80% less efficient tracks only implied shifting the burden to a new tail of unprofitable tracks (see Fig. 7.2) and taken this to its extreme they had found a strategy to reduce the railways to its

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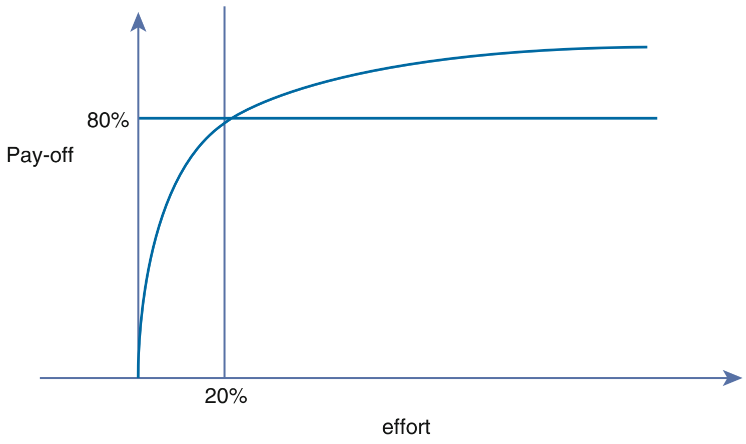

Fig. 7.1 A Pareto curve of effort vs. pay off

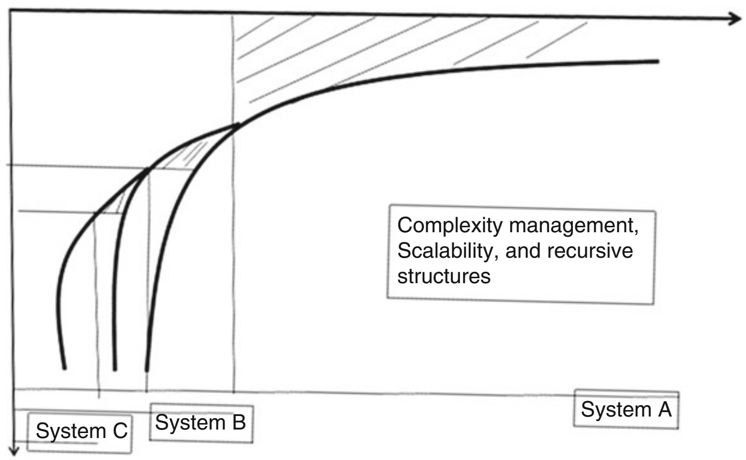

Fig. 7.2 A machine for eating the railways. Elaboration from: S. Beer (1979, p. 17)

minimum expression. Pareto curves are common in all kinds of situations and their conceptual underpinnings are becoming increasingly clear with power laws (PL).

Increased efforts for smaller pay-offs are common. We observe this convexity in economic activities, in people's and organisations' learning curves and more generally, in system-environment interactions. However, contrary to the idea of a "machine for eating the railways" as implied by the English railways example, Fig. 7.2 could be understood as "a machine for creativity and innovation" to cope with high complexity events. As efforts approach diminishing returns in an increasingly complex environment the pressure to amplify the system's own response capacity increases. The fact that events make apparent performance limitation in the current situation may trigger the need for innovation, that is, for fresh new responses. Environmental complexity is already triggering the need for new systemic capabilities (Teece 2008). The argument is that as environmental complexity increases with unexpected events, the appropriate response is, as implied by Ashby's Law of Requisite Variety (Ashby 1964) increasing the variety of the system. However, this proposition triggers a whole range of methodological questions, particularly, does it always imply increasing the variety of the system? But, one way or the other, Pareto's rule anticipates that in an increasingly interconnected world organisational systems will be buffeted by significant, often unknown, events and that unless these systems can cope with unexpected complexity with imagination and creatively their performance will suffer.

7.2 Revisiting the Law of Requisite Variety

Ashby (1964) offered the concept of variety as a measure of complexity; he defined variety as the number of *possible* states of a situation, and the Law of Requisite Variety (LRV) as a regulatory requirement for balanced interactions; "only variety absorbs variety". Usually this is understood as 'the variety of the regulator has to be as large as the variety of the reguland', or the 'variety of the system has to be as large as the variety of the environment'. However, this matching of varieties is more subtle than it is implied by these statements. Figure 7.3 illustrates the interactions between a system and its relevant environment (Espejo and Howard 1982). For a system to maintain stability within an acceptable *level of performance* or *target set* (V_T) the *disturbances or variety of environmental events* (V_D) must be matched by the system's affordances or *response variety* (V_R).[1] This performance is regulated by a regulator. Regulation in general is distributed throughout the system, as the regulator may be constituted by many self-regulating regulators (only for clarity Fig. 7.3 shows one external regulator to the system). In addition to V_D, V_R and V_T we need to consider the *variety of possible behaviours or outcomes* (V_O) of the system to anticipate control capacity. Is V_O within the set of acceptable behaviours V_T?

The LRV tells us first, that the ratio V_D/V_R is larger or at best equal to the variety of outcomes (V_O) and second, that for the regulator to have requisite variety, this variety must be contained by the *target set variety* (V_T). For human activities this target set (V_T) relates to the regulator's purposes and values. But Fig. 7.3 also helps appreciating that to achieve requisite variety the regulator needs *learning schema or models* to change controllable variables towards reducing errors between outcomes and targets. But good models and behavioural schema of the interactions between a system's actors and relevant environmental agents are not enough to change

[1] I understand affordances as *resource* supported interactions between a system's actors and environmental agents, which allow the system producing requisite responses to environmental disturbances.

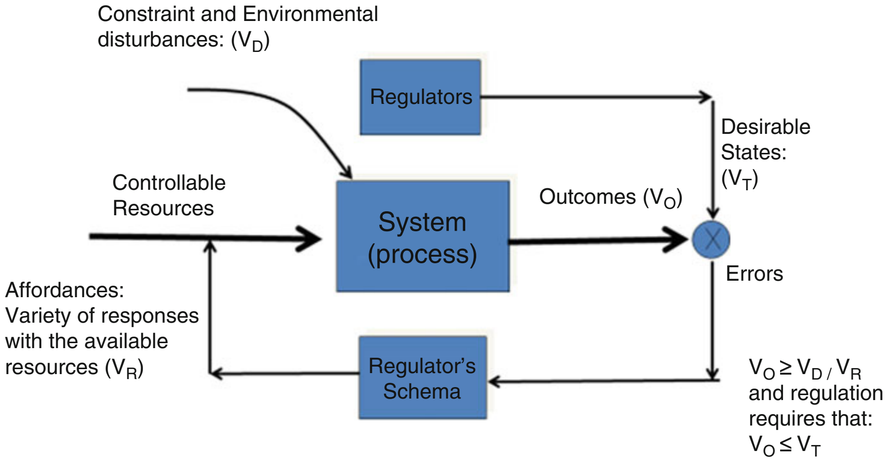

Fig. 7.3 Scalability, innovation and structural recursion

controllable variables; additionally, the regulator needs response capacity—affordances—to produce this learning. Resources are necessary to produce requisite responses. As an extension of the LRV, Conant and Ashby (1970) proved the theorem: "Every good regulator of a system must be a model of that system". Just it is necessary to keep in mind that without resources the regulator lacks response capacity.

Schema may help the regulator to work out systemic and environmental constraints but does not give requisite response capacity.

Environmental constraints, rather than chaotic, unconstraint possibilities, is what makes learning worth in a situation. In his book *An Introduction to Cybernetics* Ashby (1964, p. 134) says: "... learning is worthwhile only when the environment shows constraints". Furthermore in p. 247 he says "the variety in the disturbances V_D is not really as large as it seems... the disturbances show a constraint." Thus the case is the following: V_D has many components, each of which shows variety. The first estimate of V_D's variety puts it very high, and we are in danger of deducing (if the regulator's capacity is given) that regulation to a required degree of performance is not possible. Further examination of V_D may, however, show that the components are not independent, that constraints exist, and that the real variety in V_D is much lower than the first estimate. It may be found that, with V_R's capacity given, this smaller variety can be regulated, and full regulation or control achieved..." Thus the *discovery and implementation of a constraint* may convert "regulation impossible" to "regulation possible". If V_R's capacity is fixed, it is the only way.

On the one hand if V_T is smaller than V_O, possible outcomes are beyond the acceptable states and therefore sooner or later the situation will be out of control. No doubt the stringent is the performance criterion the less likely is that the regulator will possess control capacity and it can be anticipated that control will fail sooner or later. On the other hand, from the above arguments, a regulator can visualise and make use of environmental constraints to transform "regulation impossible" into "regulation possible". Schema plays an important role in achieving this regulatory capacity. For instance, for a company, climate regulations can be seen as environmental regulatory constraints to reduce the chances of destructive weather disturbances in its operations.

For high variety, environmental events (V_D), climate change requires high variety responses (V_R) in order to maintain people's quality of life (V_T). Unusual changes may imply high variety outcomes (V_O) i.e. floodings, and if the system's affordance or response capacity are inadequate the ratio V_D/V_R will be high compared with the variety of desirable states making the variety of possible outcomes (V_O) large and the system's regulators will lack requisite variety. V_D/V_R will be high, and the LRV tells us that the variety of possible outcomes (V_O) will exceed the variety V_T of acceptable states. In this case the system will not have requisite variety to respond to extreme disturbances. Therefore, unusual but possible events, like extreme flooding, will pose high risk to the system.

7.3 Cybernetic Explanation, Constraint, and Co-evolution

From an epistemological perspective, cybernetic explanations are negative: "Causal explanation is usually positive. We say that billiard ball B moved in such and such direction because billiard ball A hit it at such and such angle. In contrast to this, cybernetic explanation is always negative. We consider what alternative possibilities could conceivably have occurred and then ask why many of the alternatives were not followed, so that the particular event was one of those few which could, in fact, occur." (Bateson 1973, p. 375). Cybernetic explanation is focused on the constraints that discard possibilities and limits the requirements for regulation. The Law of Requisite Variety offers a powerful heuristic to visualize the need for constraints. *A system can adapt just so far as its environment is constrained, and no further* (Ashby 1964, p. 127). However hard a regulator works the outcomes of any situation lacking in requisite variety will sooner or later be out of control. Indeed, if the situation remains unchanged, an observer can anticipate that it will hit difficulties and in the end will be unsuccessful. Comparing the regulator's response capacity with the variety of possible disturbances allows a trained observer to say "there is no way that in the longer run outcomes will remain within the target set". *Thus, working out environmental constraints and designing systems to benefit from those constraints has profound social implications.* The challenge is matching their varieties at acceptable levels of performance. In a more directive sense environmental regulation is also a way of constraining its variety; regulated markets constrain disturbances for economic agents.

System's design is often necessary to match environmental variety with requisite response capacity. If performing a system's task, say its policies, does not recognise in its structure environmental constraints it may proliferate unnecessary variety, making the system's regulation unmanageable; on the other hand, chunking this

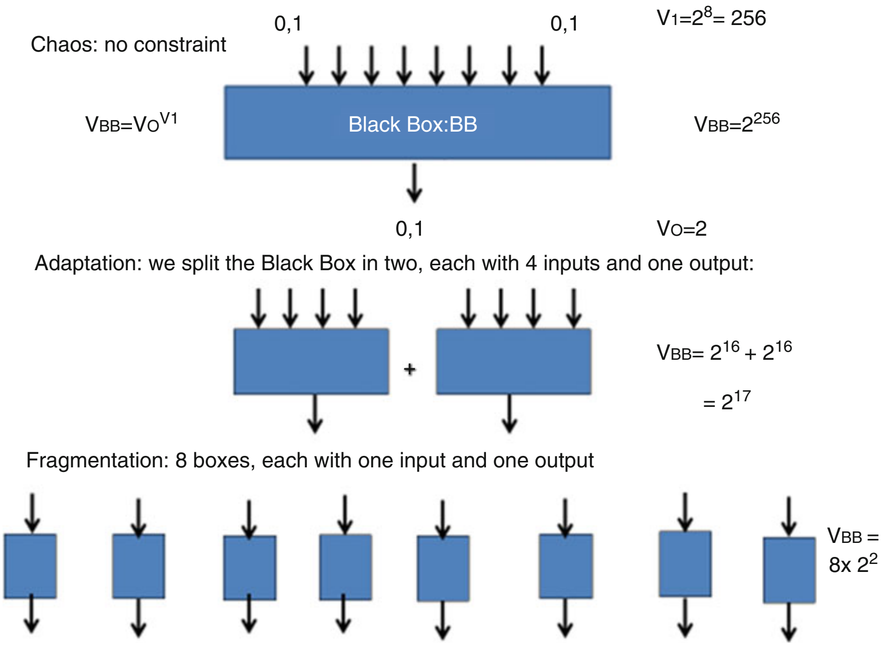

Fig. 7.4 Strategies to manage complex situations. Sources: S. Beer (1979, pp. 47–48)

task by mirroring environmental constrains, the system's complexity can be reduced in orders of magnitude (see Fig. 7.4).

Figure 7.4 illustrates important complexity management strategies for a black box in its environment. Interactions proliferate at unimaginable levels even in simple situations. For instance, with reference to Fig. 7.4, a black box with eight inputs, each with two possible states, 0 or 1, and 1 output also of two possible states, can generate 2^{256} possible states over time, which is an astronomic number of possible states (Beer 1979). Unconstrained variety proliferation makes tasks unmanageable. However, if the black box is divided into two black boxes each with four inputs and one output, the overall variety is reduced to 2^{17} (Fig. 7.4) making the situation more manageable. This variety can be further reduced if the black box is fragmented into eight black boxes each with one input and one output. Of the above three complexity management strategies, the first one, with a structure of unconstraint connectivity is chaotic. Regulators of the black box most likely will lack response variety for the system to achieve a desirable performance in its environment. The third strategy, of eight boxes, oversimplifies the situation making unlikely adequate responses to environmental disturbances; it offers a fragmented schema. However, the second strategy, of two boxes, may map better environmental constraint and offer a more adaptive strategy. The first strategy, the unconstrained *holistic* strategy, may be chaotic and beyond control. The third, the *fragmented* schema, is inadequate and may not permit the necessary connectivity to perform a task well. The second, intermediate strategy is more interesting; it is an indication of possible adaptation. The two black boxes are indeed complex themselves but they may offer more hope if they succeed mapping environmental constraints. Assuming that the division in two is mapping relevant constraints in the environment, thus concentrating response capacity where the pressure is, the variety absorption of these two boxes will deal with most of the environmental variety leaving a small residual variety to the attention of those responsible for the integration and coordination of the overall task (of the box with eight inputs and one output); this strategy can give requisite variety to the regulator "a system can adapt just so far as its environment is constrained, and no further". We are now moving in the direction of making manageable a so far chaotic situation. Regulation of the total situation—the larger box—will focus attention on the cohesion of the two autonomous black boxes to achieve a performance that makes possible the global task.

Chunking a task requires learning and adaptation to overcome fragmentation. However, for as long as the system mirrors relevant, perhaps so far hazy, environmental constraints, distributing response capacity among autonomous but interconnected chunks is indeed a good strategy to make a situation more resilient. For a system, a large complexity can be an asset but only if it is underpinned by structural constraints that mirror environmental constraints. The less we understand and exploit these constraints the more difficult will be to produce desirable tasks and achieve high performance. *Creativity can be interpreted as a discovery of constraints*. Based on these ideas is that it is possible to distinguish between senseless fragmentation and purposeful complexity unfolding (Espejo and Reyes 2011). As said before, to have a good regulator it is necessary (but not sufficient) to be a model of the regulated situation (Conant and Ashby 1970). In other words, for an organisational system to perform well in its relevant environment it must be a model of that environment. To achieve a desirable task the organisational system needs to work out constraints to achieve requisite variety. This is a challenge to creativity and innovation. The embodiment of the environmental constraints must be in the unfolding of the system's complexity, that is, in the splitting of the black box complexity into chunks of complexity that increase adaptability, resilience and reduce the complexity of the situation to manageable levels. Indeed, fragmentation happens when this break down is done without a good grasp of constraint in the environment.

Often environmental constraints are not recognised and if they are recognised this happens after the event as an outcome of painful errors and not of anticipatory creativity. In other words, often systems handle poorly the structural mirroring of relevant environmental complexity. To illustrate this point we need go no further than the economic and financial systems in recent times. Swings between centralisation and decentralisation have dominated the design of complexity management strategies. The tacit strategy of centralisation is that "bosses" know better. On the other hand decentralisation assumes that people will find their way better without regulatory interference. In few words we can say that the first strategy aims at attenuating social complexity through hierarchical structures, while the second aims at a proliferating social complexity by reducing controls and assuming that self-regulation and self-organisation will make the trick. Unfortunately, both strategies have produced social and economic fragmentation, the first mostly by imposing unnecessary restrictions and the second by weak regulations. Complex social systems are networks often underpinned by incompetent fragmentation or by fostering dangerous connectivity. For instance, the economic system requires articulation and co-evolution with financial services in its environment. Financial services are environmental enablers of the economy, and following Conant and Ashby, to achieve economic development at an acceptable level of performance, mutual co-development and co-regulation must follow economic policies and map the economy's unfolding of complexity from the local to the global; economic aspects must intertwine with financial aspects at all structural levels. The strategy of having structurally large financial services with emphasis on the global economy, that is, financial services dominated by large international banks weakly coupled to local economic agents can be seen as responsible for the economy's weak unfolding of its complexity. The environmental constraints experienced by production enterprises do not strengthen their co-evolution with financial services, which are more interested in their own viability. We can expect that this structural arrangement does not help a healthy economic development. The large interconnectivity of financial services more focused on their own viability than on the viability of production enterprises increases the chances of a weak complexity unfolding of the economy. Decentralisation of financial services mirroring the economy's commercial enterprises should be beneficial to the global economy in the longer run. As said before a system can adapt just as far as its environment is constrained, and no further.

To summarise, an economic system in an environment of financial enterprises more focused on their own viability than on success of the enterprises constituting the economy, and in need to perform well in competitive markets, are likely to trigger a dysfunctional break down of the economy's tasks, that is, of a dysfunctional unfolding of complexity that increases the chances of less focused enterprises with less stable relationships. Regulators of these relationships need to constrain environmental complexity to give requisite variety to enterprises. The evolution of these financial enterprises as autonomous, dynamic non-linear systems makes them sensitive to small changes and to self-organised criticality, which increase the chances of dangerous cascading effects as it was the case in 2008 (Haldane and May 2011). This case may threaten not only their viability but the viability of the economy as well. In other words, a small addition of risk may produce big unexpected changes as the system reaches its self-organised criticality. With reference to the 2008 financial crisis "a single sub-prime grain produced the self-organised criticality of the financial sector" (Haldane and Nelson 2012), and challenged the stability of the whole economy. Without building appropriate 'walls' (i.e. constraints) crises may spread rapidly throughout the system.

7.4 Power Laws and Organisational Scalability

The strategies of an organisational system to maintain dynamic stability with its environmental agents requires attention to constraints and co-evolution. *A system can adapt just so far as its environment is constrained, and no further* (Ashby 1964)*, and the system requires creativity to co-evolve and recognise environmental constraints to increase its adaptability.* This co-evolution was illustrated for the economy's interactions with financial services. Two aspects need attention; on the one hand learning how organisational systems absorb and develop environmental complexity through their structures and behaviours, and on the other hand how environmental agents constrain the variety of their disturbances to the system by self-regulation and self-organisation and also, in policy terms, by guided self-organisation (Gerschenson 2015).

These are exceedingly complex situations dominated by proliferating interactions that cannot be accounted effectively by Gaussian normal distributions; to develop a view of the system's behaviour through aggregations of independent facts is only relevant for linear interactions. Systems interactions with interconnected environmental agents are accounted by often infrequent and high complexity events. The patterns of these events are captured by power laws that follow 'long tailed' Pareto distributions as in Fig. 7.1. The 80/20 rule is a fingerprint of their systemicity. The performance of the English railways depended in more than cutting off the tails. These tails suggest systemic interactions and tacit complexity absorption strategies that can be described by power laws. These laws describe a wide variety of situations. For instance nature absorbs complexity following the "Square/Cube Law" responsible for producing fractals; "In an organism surfaces absorbing energy grow by the square but the organism grows by the cube, resulting in an imbalance; fractals emerge to bring surface/volume back into balance" (Boisot and McKelvey 2013, p. 68). Another power law in natural and also social systems is the form in which organisms and organisations evolve as their components recognise the limits of "*connecting costs*", which trigger the formation of organs and cells in organisms (McKelvey et al. 2012) and units with organisational closure in organisational systems (Beer 1979; Maturana and Varela 1992; Wene 2015). Complexity unfolding, the cascading of autonomous systems within autonomous systems in organisations (Espejo and Reyes 2011) is the outcome of self-organising processes when an autonomous system hit the limits of *connecting costs* and need larger embedding or smaller embedded autonomous systems to deal with the proliferating complexity. Top-down situations require unfolding their complexity into autonomous systems within autonomous systems simply because the global system cannot cope with the unmanageable complexity of interactions with environmental agents. In bottom-up situations, as environmental complexity grows locally, an autonomous local unit may need to coordinate its activities with others to produce a larger organisational system. These are processes that underpin the emergence of very large organisations. *Connecting cost* is accounted by power laws. We know that most enterprises are small and a few reach very large sizes and we anticipate that their distribution follows a power law. Another power law is "self-organised criticality", this happens in situations where non-linearity and amplifications of small changes produce dramatic non-linear outcomes; these are instances of *accidents frozen in time* (Boisot and McKelvey 2013). Woods are instances of situations containing accidents frozen in time; a small fire in a forest may be contained or otherwise depending on the existing fire walls or constraints built up into the forest, suggesting that structural aspects underpin the way the fire unfolds, either to containment or to a natural catastrophe, that is, a high variety event. Similarly, the almost melt-down of financial institutions in 2008 was a case of sub-prime financial products, whose failure could not be contained by the financial system because the banking systems was too interconnected; failure to understand how to deal with the connecting costs of an overblown financial system blinded policy makers to see that they had to build up constraint and support co-evolution with production enterprises. The financial system lacked structural constraints to restrict the damage that small institutions originated in larger financial institutions (Haldane and May 2011). With the support of power laws and organisational cybernetics policy-makers and regulators could have reflected upon the co-evolution of the economic and financial systems and discussed their structural recursion to build up walls to contain the failure of small institutions avoiding reaching the point of banks too big to fail. Good cybernetics of the financial system would have reduced the damage (Espejo 2015). And, with the support of power laws it would have been possible to work out systemic events and environmental behaviours highlighting unconstrained interactions favouring the spreading of the crisis; outliers emerge from social systems and environments in co-evolution.

Figure 7.5 offers an alternative way of describing 80/20 distributions with the use of log-log diagrams (McKelvey and Boiset 2009). It distinguishes the Gaussian and Pareto worlds. Cognitively, people account for small events of high frequency (the left side of the figure) using mean values and standard deviations; this is a way for them to give order to data, on the other hand large and infrequent events (like those in the right side) cannot be accounted unless cognitively we accept systemicity and find empirical evidence fitting power laws; these outliers of different size fit the negative slope of the diagram.

In terms of risk management, we are aware of the uncertainties stemming from the non-linearity of situations dominated by 'butterfly effects'. Social situations are dynamic non-linear systems in which, as illustrated for the finance system, small changes in some of its components may trigger unexpected and large effects in time. These systems are dominated by uncertainty and not by measurable, centrality driven, risk; they may experience unexpected black swans or outliers or extreme behaviours (Taleb 2008). Since it is not possible to anticipate how or when small changes will produce black swans, fitting power laws to already experienced outliers may help anticipating necessary system's capabilities to deal with the unexpected as and when they happen. This anticipation requires organisational systems with response capacity to deal with distributed outliers that fit power law distributions, avoiding the chaotic overloading of a poorly structured organisational system experiencing *connecting cost*. Structural recursion becomes a complexity

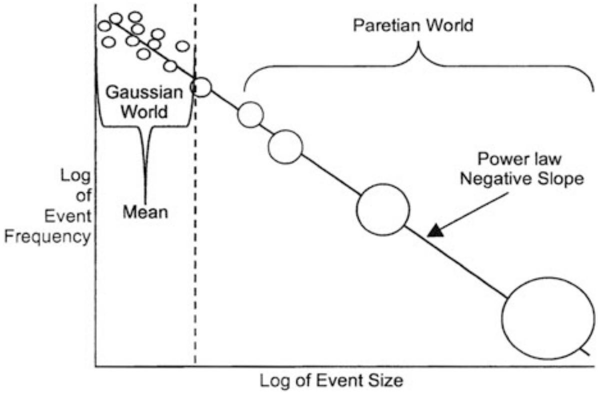

Fig. 7.5 Gaussian and Pareto Worlds. Source: McKelvey (2013) Stylized Pareto distribution on log-log scales

management strategy closely connected to frozen seeds of extreme events. In this perspective, the increasing connectivity of systemic components and their related proliferating environmental complexity may trigger adaptive organisation structures better prepared to deal with the unexpected. *Good cybernetics, supported by empirical research, is a must for policy processes aimed at co-evolutionary processes to improve the response capacity of systems, making them more adaptive and resilient* (Espejo 2015).

What is apparent is that for a system the 80/20 distribution expresses interconnectivity and complexity while the cognitive schema of people working with Gaussian distributions, of averages and standard deviations, imply orderly events which can be managed as aggregations of independent events. However helpful this latter approach might be to deal with already structured situations, it offers an unrealistic view of a complex world. Power laws give us the chance to build up response capacity to unexpected, problematic situations, which reflect systemicity at several levels. These are risky and unpredictable problematic situations with increasing need for creativity and innovation, beyond the standard responses of linearity. They produce Pareto tails that require distributed adaptation and learning. The English railways' attempt to cut off the tail of diminishing returns was a recipe to destroy its complexity and functionality. Pareto distributions of unexpected behaviours recognise connecting costs, self-organised criticality and other forms of systemic behaviour that require high variety responses. These behaviours may indicate high variety events lacking appropriate adaptive responses and possibly systems operating in dysfunctional chaotic regimes or fragmented regimes (the first and third complexity management strategies discussed before in this paper) that fail achieving adequate performance. These would be organisational systems failing to co-evolve and adapt to complex environments. Systems would benefit from policies building up constrains in their co-evolution with environmental agents. For *complex adaptive systems,* these are the hallmark of scalable structures, such as Beer's recursive structures (Beer 1979).

7.5 Scalability

Even small social systems experience *connecting costs*, which, to avoid chaos, require a cascading of autonomous systems. Responses to high variety stimuli require the unfolding of a structure with capacity to respond adaptively to environmental situations. This implies attention to environmental constraints and building up affordances supported by innovative schema and resources. Figure 7.3 offered a view of the interdependence of response requirements and environmental disturbances for effective regulation. Improved and innovative schema helps seeing constraint in chaotic disturbances; it helps attenuating environmental variety and exploring for more affordability (i.e. resources) to achieve requisite variety. No change in schema implies business as usual and makes more difficult finding seeds (chaotic attractors) to structure complexity. Finding out constraints is essential to work out necessary affordances for adequate performance. However, it is not enough to find appropriate schema, it is also necessary to build up capabilities to respond to disturbances. In Fig. 7.3 V_R is the structural and organisational resources *producing* responses to disturbances. It embodies the capacity to produce responses. Without this capacity schema is in the system's informational and not in its operational domain (Espejo 2000). Faced to unmanageable *connecting costs* the system depends on scalability for adaptation and requisite variety. As already said structural recursion is by and large the outcome of self-organizing processes, which may drive bottom-up scalability, like in the case of small communities growing into cities, but also, may drive top-down scalability like in enterprises decentralising their resources.

The Pareto curves of Fig. 7.6 can be visualised as a heuristic to support the scalability of recursive processes. Rather than curves highlighting decreasing returns they can be seen as heuristics to see the need for an organisation's distributed creativity and innovation. Empirically, as decreasing returns take place at one level, growing *connecting costs* make necessary the scalability of resources for the distribution of creative responses to environmental complexity through new schema. This is a heuristic to increase the robustness and resilience of organisational systems, which requires guiding policies of scalability to strengthen processes of self-organisation in the system and its environment.

Dealing with the huge complexity of social situations requires enabling the scalability of organised complexity; capabilities for fluid adaptability and potent cohesive operations within multiple operations at multiple structural levels. This is perhaps, the most powerful strategy to increase response capacity to disturbances and black swans. From the perspective of guided self-organisation we talk about complexity unfolding and adaptation to an environment with constrains; the social situation offers an adaptive emergent complexity at the edge of chaos. Guided self-organisation is the encounter of the top-down and bottom-up emergent complexities. We may consider black swans as crystals in problematic environments that offer opportunities for catalysing self-organisation. Large problematic events may require multiple structural recursions to maintain the situation under control. Black

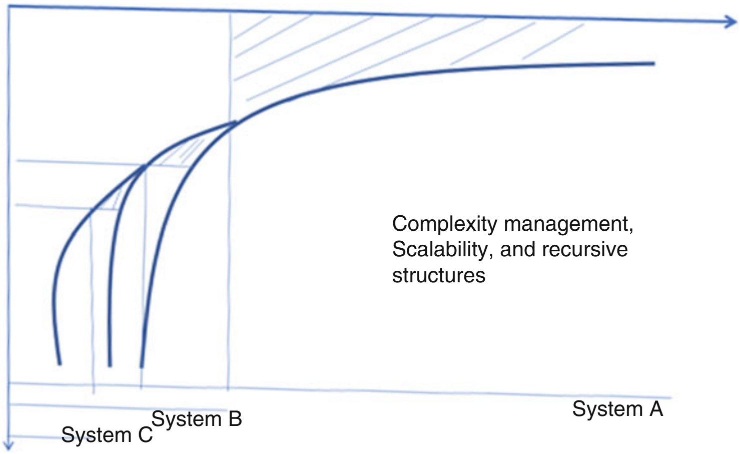

Fig. 7.6 Scalability, innovation and structural recursion. Elaboration from: S. Beer (1979, p. 17)

swans are also distributed events that take place from the global to the local; this is the fingerprint of their structural complexity. Structural scalability reflects the situation. From an empirical position it is important to work out power laws for events potentially disturbing the situation. For example, we may expect that the growth of a city increases potential risks for its citizens and unless the city scales both up and down this growth through recursive structures it will fail providing resilience from the global to the local. The explosion of civil unrest—a black swan affecting a community—may weaken its global fabric. Structural scalability offers constrains to limit the impact of self-organisational criticality.

7.6 Conclusions: An Agenda for Further Research

This paper offers a heuristic for organisational effectiveness; how is it possible for any of our social endeavours to be resilient in highly uncertain environments. The systemicity of our world, the connectedness of all of us in spaceship Earth, makes individual and/or collective social enterprise risky. Constructing effective organisational systems requires making them resilient to the unexpected. These systems have to be prepared to deal with unimagined situations. The fingerprint of complexity in this uncertain environment appears to be power laws that provide anticipations of how complexity organises itself. These power laws are manifestations of constraints in the environment. They don't tell us what is going to happen but they connect butterflies in the Amazon to storms in the northern hemisphere. This complexity, often chaotic, triggers unexpected events and also puts pressure in managing situations at the edge of chaos. In this paper I have argued for increased efforts to learn about these power laws; this is an empirical challenge, since their distributions provide hints about complex adaptive systems, in particular of self-organised criticality as expressions of the constraints that organisational systems need to deal with in this interconnected world. It is constraint that makes more manageable the surroundings of organisational systems and in some cases makes them successful for the good of the people. Supported by the Law of Requisite Variety and its derivation that "Every good regulator of a system must be a model of that system" I have explained the requirements to achieve good performance, which entail innovative and creative schema and well-structured affordances. To achieve distributed adaptive schema and also distributed affordances I have argued for the scalability of organisational systems and in particular for complexity unfolding into autonomous systems within autonomous systems (Beer's recursive structures, Espejo and Reyes 2011).

I have hypothesised that power laws apply to unexpected events and that rather than producing crises responses after these events it is wiser to build up scalability in social structures, supported by discovering environmental constraints and by matching organisational structures, knowing that responses with requisite variety will be necessary. As complex problematic events happen their consequences require responses with effective structural recursion as implied in Fig. 7.6. It should be possible to check empirically black swans anticipating black swans and connecting them to appropriate organisational systems operating at the edge of chaos. This closeness is necessary because maximum emergence of new organisational forms will occur with maximum information i.e. minimum predictability, while minimum emergence will occur with minimum information, i.e. maximum predictability, that is, closer to an ordered regime (Gershenson 2015). In the language of this paper, while the latter may benefit from Gaussian distributions to study behaviour, the former may benefit from power law distributions.

Self-organization has been used to describe swarms, flocks, traffic, and many other systems where local interactions lead to a global pattern or behaviour. These are situations where coordination and cohesion produce new patterns or behaviours, which are the ones that anticipate unexpected events and require new schema and organisation structures. Guided self-organization (Prokopenko 2009; Ay et al. 2012; Polani et al. 2013) should help steering self-organizing dynamics towards a desired configuration of an organisational system (Gershenson 2012).

Black swans are events for which often there is no response capacity, at the cost of people and organisations and the challenge is to anticipate building up capacity to make possible this response. If the event makes apparent the need of a global response, but the response schema is not modified in the system the chances are that new episodes without response capacity will emerge. We may assume that the huge complexity of the situation will trigger events that follow power laws distribution. These are the hypotheses that need further research.

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