Good social cybernetics is a must in policy processes.

Structured Abstract:

Purpose

Illustrate supported by Beer's Viable System Model and four vignettes the relevance of self-organisation, recursive structures, self-reference and reflexivity in policy processes.

Design, Methodology, Approach

First, the concepts of self-organisation, recursive structures, self-reference and reflexivity are briefly discussed to ground policy processes in good cybernetics. Then, with the support of four vignettes, the idea of good cybernetics in policies processes is illustrated.

Findings

The cybernetics of policy processes is often ignored.

Limitations

If the purpose of this paper were to influence policy-makers it would be necessary to further the empirical base of the four vignettes and clarify desirable forums to ground the relevance of self-organisation, recursive structures, self-reference and reflexivity in policy processes.

Practical and Social Implications

Beer's recursive structures, self-reference and reflexivity have much to contribute to the betterment of policy processes and the amelioration of the unbearable social and organisational costs of many current policies.

Originality

The application of concepts such as self-organisation, recursive structures, self-reference and reflexivity adds to our understanding of policy processes.

Keywords: Viable System Model, policy processes, self-organisation, structural recursion, self-reference, reflexivity

Article Classification:

Conceptual paper

Introduction

Policy processes are necessary to respond to issues such as development of clean energy, child care, transparent marketing, economic development and so forth. Multiple social and economic agents interact in the creation, regulation and production of these policies and through these interactions, mostly by self-organisation, they produce organisational systems.

Self-organisation brings together social agents as they find common purposes and recognise the need to interact. But chance interactions may take too long to form policies and some form of guidance, such as political leadership, incentives for particular relations, resources allocation, applications of disruptive technologies and others may help in these processes. These are catalysts of *organisational systems,* which transform agents' collectives into actors

of policy systems[1]. However, it is common for agents to have a poor appreciation of the resources and interactions that are necessary to make particular policies viable, leading to painful shortcomings for people and society. Beer's Viable System Model (Beer, 1979, 1981, 1985) offers a heuristic to construct policies through effective communications. This model highlights requirements to enable the emergence of organisational systems from fragmented resources. Among these requirements are organisational closure, structural cohesion, value co-creation, structural recursion of autonomous units within autonomous units and others. These are requirements for a good cybernetics of policy processes.

I illustrate these requirements through four vignettes; child services in England, a small company´s marketing activities in the English Midlands, alternative energy technologies and global financial services. The child services' vignette illustrates weak communications between national regulators, local policy implementers and stakeholders. This is an instance of inadequate *relational self-organisation*. The marketing vignette is an instance of a company that fails developing value co-creation with customers, with the consequence that customers impose their requirements and the company fails to create products of its own design. This is an instance of weak *relational reflexivity*. The third vignette is an instance of a weak identity of the energy sector as it fails to integrate under the same policy framework energy technology development and energy production. This is a case of a *fuzzy self-reference* as necessary relations between actors focused on the "outside and then" and on the "inside and now" (Beer, 1985) fail to be developed. The last vignette relates to the 2008 financial crisis. This is an instance of a market driven *self-organisation process that* failed to recognise that financial services had to go hand in hand with the *recursive structure* of the economy from the global to the local.

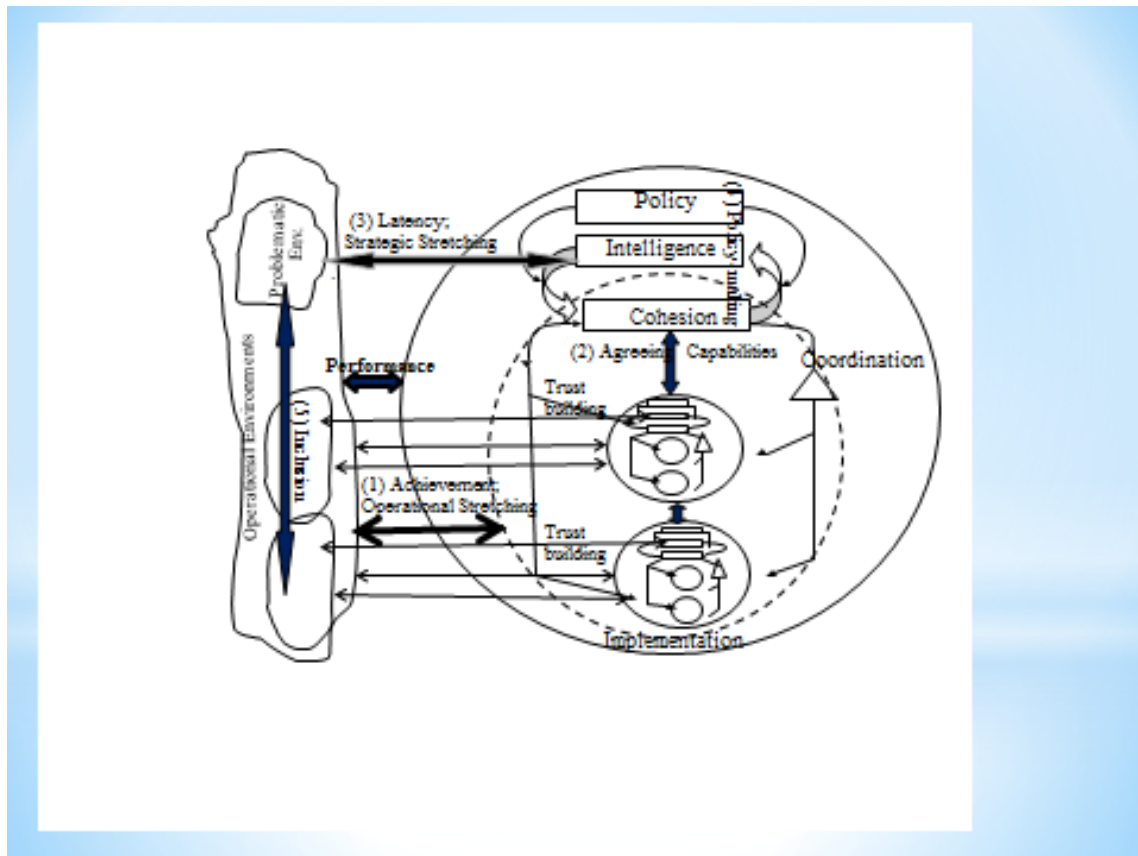These are all instances of situations driven by poor cybernetics.

After a short exploration of the Viable System Model as well as of organisational systems, self-organisation, recursive structures, self-reference and reflexivity the paper develops the four vignettes.

The Viable System Model; the Cybernetics of Policy Processes

The embodiment of policies in effective dynamic structures increases the chances for their successful implementation. In general policies emerge from shared purposes and values. Indeed, agents from varied provenances may form networks as they share common interests and an ethos that facilitates their interactions. These networks may evolve into organisational systems as an outcome of unplanned and serendipitous interactions. Myriad interactions influence the emergence of these systems. For instance a policy for child care, as is discussed later, needs contributions of at the very least social, health and police services. Often these services are fragmented, at the cost of child care. Self-organisation takes place as agents

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[1] I distinguish throughout this paper agents and actors. I use agents in the common sense of entities which are capable of action, and actors in the sense of agents constituting an organisational system, which can be any agent in the system-in-focus, whether constituted as an autonomous actor or as a non-autonomous actor in this system. The implication is that agents are entities in the environment of *this* system, though these agents may be actors constituting other organisational systems.

develop relations around tacit or explicit purposes/policies[2]. Self-organisation constitutes *agents as either autonomous or non-autonomous actors* of an emerging organisational system (Espejo 2002, Espejo and Reyes, 2011). What is necessary for success is that they find effective forms of creating, regulating and producing these policies. These are functions anticipated by Beer's Viable System Model:

Policy · Intelligence · Cohesion · Coordination · Implementation · Performance · Trust Building · Problematic Env. · Operational Environments · (3) Latency; Strategic Stretching · (2) Agreeing Capabilities · (3) Inclusion · (1) Achievement; Operational Stretching

To make a policy happen[3] aligned autonomous actors, with their self-constructed policies, *produce* a larger organisational system; they are contributing with their resources to its embodiment. Autonomous actors amplify the organisational system's capabilities (circles in the above figure). As they align their interests/purposes they unfold the organisation's complexity. This unfolding in network structures is driven by self-organisation and happens at multiple levels down to the most local level. These self-organising processes enable autonomy within autonomy, and for as long as they are aligned, they are powerful amplifiers of social complexity. Indeed complexity unfolding produces complexity at vastly larger scales than hierarchical structures.

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[2] Self-organisation is defined as the transition of a system into an organised form in the absence of external or centralised control. Thus, one may emphasize two key features of a self-organised system or process: (i) an increase in organisation (structure and/or functionality) over some time, and (ii) the local interactions are not guided by any external agent. See Ay, N. et al. (2012).

[3] Beer's System 1 and Espejo's Implementation Function (Espejo 1989)

For policy regulation self-organised non-autonomous actors contribute to the cohesion, coordination, intelligence and policy functions of the organisational system[4]. Autonomy has to go hand in hand with a cohesive structure. At least three aspects contribute to cohesion; resources bargaining, self-regulation and moment-to-moment coordination of actions. These aspects are necessary for amplification and attenuation of complexity (Beer, 1985, Espejo and Reyes 2011). Self-regulation to be effective needs responsible trust among actors[5] and coordination requires among other aspects sharing ethos, language and standards[6]. Responsible trust requires means for the mutual testing of competencies and sincerity. Moment to moment coordination of actions requires communications with and without channel capacity (Conant 1979) and resources bargaining requires negotiating dynamic capabilities.

For policy creation resources and relations focused on the 'inside and now' (cohesion function) and the 'outside and then' (intelligence function) are necessary. The orchestration of their relations and the monitoring their balanced contributions to policy processes is the role of the policy function.

Also as anticipated by Beer's principle of structural recursion we may expect that self-organisation produces 'autonomous actors' at several structural levels (circles in the above figure), all striving for the creation, regulation and production of their own policies. However it is common, as illustrated by the second vignette below, that structural recursion is inhibited by hierarchical management.

Relations between actors and agents are driven by expectations and the need to perform. These are learning relations of value co-creation, constantly changing as contextual and environmental conditions change. Indeed, environmental complexity is growing for enterprises as they move from solely economic performance to social, ecological and economy performance. These are conditions stretching actors to sense and seize opportunities to meet learning challenges and create and produce new dynamic capabilities (Teece, 2008). Environmental stretching is a driver for re-configuring resources. Environmental challenges trigger alternative forms of complexity unfolding. New autonomous units may emerge thus de facto changing capabilities. But, making effective different constellations of autonomous actors requires attention to maintaining and extending the cohesion of autonomous units.

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[4] Beer refers to these resources and their relations as the System 2, System 3, System 4 and System 5 of an organisation. Espejo refers to these systemic functions as the Coordination, Cohesion, Intelligence and Policy functions (Espejo, 1989).

[5] Responsible trust requires in Beer´s terms auditing, role of S3*

[6] System 2 in Beer's VSM

The Cybernetics of a Situation: Variety Balances, Complexity Unfolding, Self-reference and Reflexivity

Good cybernetics requires first, matching relational varieties at the least cost to people and organisation and second, actors' and agents' awareness of, and participation in, these relations. These aspects are developed in what follows:

1. Variety or the number of possible states of a situation *measures* its complexity (Ashby, 1964). This measurement is principally relational: how is a situational variety matched by the regulator's variety? This requires clarifying expected outcomes and most importantly, how self-organisation produces this matching. Should producers meet the expectations of customers we would say that they have *requisite variety for this purpose* (Ashby, 1964). Should they not guided self-organisation is necessary. It is natural to have complexity asymmetries in all kinds of relations. In a large market with many potential customers demand can overwhelm producers. On the other hand if the interaction is between one customer and one producer about technical matters the likelihood is that the producer's complexity will be larger than the consumer's. Variety, or, in this case, the number of possible states of consumers and producers for the purpose of developing a market relationship, is used as a measure of their complexity. For as long as a relation is maintained variety operators amplifying low variety and attenuating high variety emerge as an outcome of self-organisation.

    Since complexity asymmetries are natural, balancing varieties between actors and agents willing or forced to maintain their relation requires variety operators (amplifiers of the lower complexity side and attenuators of the higher complexity side), and the most interesting regulatory situations are those of co-regulation, in which both sides regulate each other. In situations where environmental agents possess more variety than organisational actors the more effective is their self-organisation and self-regulation the smaller will be the residual variety that they will leave locally unattended for actors' attention. On the other hand, the more effective is the actors' self-organisation and self-regulation the larger will be their variety to meet agents' expectations.

2. An autonomous organisational system is operationally closed, that is, it forms and controls all its operations (Maturana and Varela, 1992). Each operationally closed autonomous actor creates its own cognitive domain different to that of the organisational system it is part of. It co-constructs value propositions with environmental agents and develops its own problem solving capabilities. Closure gives it an *identity-in-use* that often is different to the identity that *actors espouse* for the organisation (Argyris and

Schon, 1976). In such a system guiding self-organisation requires guiding complexity unfolding and cohesion towards a *desirable identity* that is not necessarily the same as the identity espoused by the actors. Policy-making has much to do with this desirable identity. Guiding an organisation's unfolding of complexity aims at matching organisational capabilities with agents' expectations in a co-creation process. Self-organisation as the Viable System Model tells us triggers autonomous actors within autonomous actors at several structural levels, and in this process they require the cohesive glue of non-autonomous actors consistent with the system's desired identity. What the organisational system does, as observed by environmental agents, is its identity-in-use, which may be different to both the actors' self-computed espoused identity and the desired identity for the system. Therefore, interactions between non-autonomous and autonomous actors may produce an identity-in-use different to the identity espoused by policy-makers. This situation may have significant implications for fairness, inclusion and organisational learning as is illustrated for the energy sector and the global economy in the Vignettes 3 and 4 below.

3. Guiding policy processes requires supporting self-reference[7] and reflexivity[8]. Self-reference is an operation where the organisation's intelligence resources compare over time identity-in-use with espoused identity to support policy-makers, who may be interested in a desirable identity (Beer, 1985). This comparison is nurtured by reflexivity; actors observe and compare the organisation's doing as fed back by agents in the environment with their own computations of this doing (as participants). The condition of operational closure, as introduced before, has a very important consequence expressed in von Foerster's closure theorem: in every operationally closed system there arise Eigen behaviours (Foerster von, 1984). These Eigen behaviours produce identity. The stronger are the agents' feedback the clearer is the chance for actors to work out the system's identity-in-use and compare it with their espoused identity. In other words, the stronger are the chances for actors to act upon themselves, that is, for self-reference. However, if expected "autonomous actors" fail to achieve operational closure any feedback coming to them comes back to individuals rather than to "autonomous actors"; this feedback may

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[7] Self-reference produces paradoxes, which can be traced back to the epistemology of identity. Louis Kauffman (2003) discusses self-reference "In Eigenforms-Objects as Tokens for Eigenbehaviors and also in personal communications to the Cybernetics Discussion Group <CYBCOM@HERMES.GWU.EDU>. He discusses Heinz von Foerster's concept of an eigenform, wherein an object is seen to be a token for those behaviours that lend it (the object) its apparent stability in a changing world. He attributes to Heinz von Foerster (Foerster, v. 1981) the proposition "I am the observed relation between myself and observing myself". This defines the concept of "I" as an eigenform of the transformation T(x) = "Observed relation between x and observing x". In the arising of a solution to the equation I = T(I), "I"'s come into being. They are not part of the status quo of the systems that engender them. They are transcendent to those systems and are often seen as illusory or otherwise magical. Observing systems can have "I's" they do not produce them. They are them. These are the eigenforms of self consciousness in the realm of names. Self-reference, the action of a domain upon itself, leading to cognition, is the beginning of the realm of eigenforms in Von Foerster' world. "I am I" is the shortest explicit loop. "I am" is the shortest prescription for eigenform.

[8] As for reflexivity "There are two possible conceptions of observation. In the first an observer creates a mental model of some object or process that is observed. In the second an observer creates a mental model of himself observing an object or process" and then argues that "Indeed a social system seems to contain only reflexive systems." (Umpleby, 2010). Therefore, reflexivity underpins value co-creation processes as in discussed in Espejo and Dominici (2015).

support their individual learning, but not organisational learning; actors lack shared mental models. Operational closure of autonomous actors is necessary for them to compare their doing in the environment with their own computations of the agents' feedback of this doing or reflexivity. Actors are observing their relations and participating in their co-production (Umpleby, 2010). If the computation is a good dynamic model of the situation being regulated (Conant and Ashby, 1970) the chances of learning grow over time. Actors' actions underpinned by good self-referential complexity management strategies and reflexivity contribute to identity formation and value co-creation with agents (Espejo and Dominici, 2015). This is an important issue for the network society; much effort is lost as agents aim chaotically at value co-creation. Beer's argument for real time is a strategy to improve these computations; unfortunately actors often manage a surrogate world (Beer 1973). Beer's Viable System Model offers a powerful guiding heuristic for those aiming at transforming a collective of agents into actors of a self-referential organisational system. Vignette 2 below illustrates aspects of reflexivity affecting the marketing problems of a small engineering company in the UK.

4. Empowered agents are necessary to stretch actors and engage them in value co-creation. Particularly when agents (e.g. citizens and customers) are dispersed their empowerment requires enabling their self-regulation and self-organisation. Agents in the environment have their own purposes and it is in their on-going communications with actors that value co-creation takes place. It is as an outcome of this process that autonomous actors emerge in the organisation system and also in the environment for different purposes. In these communications actors are not only producing products and services for their "customers", but also, developing self-awareness of this production and are more or less successfully computing models of this doing. Agents and actors are learning when they are mutually engaged in value co-creation. It is in these communications that meanings emerge. "Reflexivity occurs in social systems when an actor observes and thinks about his or her actions and their consequences and then modifies his or her behaviour" (Umpleby, 2007). Epistemologically, whenever the products of an organisational system are objectified it signals that this system is not engaged in a formative process (Eigen formation); the asymmetry between actors and agents is dominated by one at the expense of the other limiting value co-creation An "objective" product is more likely to emerge from hierarchical organisations, on the other hand value co-creation relies on purposeful recursive structures with large capacities to create distributed, but aligned, meanings. This situation is mirrored in the environment. Disempowered agents, as ordinary customers often are, have a limited capacity to stretch the organisational system decreasing its need for structural recursion; this situation makes more likely "objective" products, lacking the advantages of co-creation. On the other hand empowered agents can see better means for self-regulation and self-organisation, thus articulating their needs and demands as stronger "consumer" groups; the organisational system will be stretched for more structural recursion to satisfy their expectations. Weak agents, lacking organisation for varied issues, can have deep implications for structural recursion and performance as is illustrated for child care in the first vignette below. But also, these self-organising processes can have profound implications for the global economy as is illustrated by the

last vignette below; disempowered agents, as often they are in less developed national, regional and local economies, can trigger dysfunctional unfoldings of complexity that often policy-makers don't recognise. They accept as natural a bad cybernetics.

The above provide criteria for good cybernetics.

Case Studies

The cybernetics of four policy situations is illustrated with the support of vignettes. The first vignette illustrates some of the shortcoming of child services in England in recent years. The second makes apparent the degree to which weak structural recursion in an enterprise hinders its marketing policies. The third vignette shows limitations in energy innovation when energy technology development enterprises have energy production enterprises as their markets rather than the final energy users. The last vignette illustrates the cybernetics of the 2008 economic and financial crisis.

Case 1: A National Structure for Local Child Services

This vignette relates a community empowerment policy to a national policy for delivering local services in an English local authority. It shows that a good community empowerment policy may not produce the desired results if the self-organisation underpinning the local delivery of the national policy is inadequate. We may expect that the value co-production between the local delivery organisation and the community will be deficient. This is the case of a failed local child protection policy in a context in which community empowerment had had priority.

In the early 2000s the Home Office in England was engaged in a policy to empower local people. Through the Active Learning for Active Citizenship and Take Part programmes significant resources went to strengthen the capabilities of local communities. The aim was strengthening people's stretching of local services, among others child care. In parallel child care failures were in the media's eye. These failures led to parliamentary debates and government actions. The performance of a service in its relations with a local community was under scrutiny.

There is evidence that a majority of citizens feel that their influence in local decisions is limited (Espejo and Mendiwelso 2011) but, in this situation, even more influence may not have been enough to improve their interactions with local services. Increasing performance is more complex than increasing citizen's capabilities. Achieving a better relational performance requires more than building local capabilities; it also requires improving the organisational structure of the related services.

The focus is on the organisational system for child care in a London district. As many other policies, child care brings together a wide range of resources such as health services, education, police and local government. Additionally, in England, a national regulator monitors its performance. We may expect that empowered communities will stretch

government services to guide their self-organisation and get better services. However to tango two persons are necessary; it requires strong autonomous actors and strong community organisations. Unfortunately, with child care in Haringey, a London borough, the local services had a weak structure.

Politicians under pressure often fail to see how to guide effective self-organisation. The example of *The Tortured Life of Baby P* tragically illustrates this point. Baby P, a one and half year toddler, died in hands of his mother and two others in the London district of Haringey (Economist, Nov 20th 2008).

The child was in the list of Social Services children at-risk. In the last six months of his life the child had been seen not less than 60 times by doctors, social workers and others. In spite of that the child had a cruel death. A previous public inquiry triggered by a similar event in the same district had recommended an overhaul of social services in England *and in particular yearly child care performance reports*. However, sadly, this response was not good enough to avoid baby Peter's death. Not long after his death another report was issued by the English Child Protection regulator. The new tragedy had made apparent the inadequacies of relying in just reports; in the future yearly visits to every child protection unit in the country had to take place to assess performance on the ground. The approach to guide self-organisation for child protection in England was again off the mark; child protection services are embedded in local authorities and not directly in a national child protection agency, thus in terms of structural recursion it should be expected an autonomous child protection unit in each local authority monitored by this authority and this authority monitored by a national body. The reason for this is simple, one must assume that corporate managers in local authorities negotiate with child protection services (as with all other service departments) the allocation of resources for their programmes and therefore continuously monitor their performance, and not only once a year. In the end, the local authority is accountable for the services' performance. Local authorities with a weak resources bargaining process, which was an outcome of the national intervention, are more likely to use hierarchical management and therefore are more likely to trigger poor services' performance are these are inhibited to engage in value co-creation with local agents. The earlier similar event in the same district was pointing to its local authority. Yet at the time no one was asking publicly for a revision of Haringey District Council's processes and structure and since the monitoring was national the local authority's failure in monitoring its services was off the hook. From a structural perspective, to have a national regulator monitoring the performance of hundreds of local child services around the country is a poor appreciation of the complexity of this monitoring. Monitoring in this case had to be a means of building up trust and cohesion within the local authority; trust and cohesion are unlikely to happen with a well-rehearsed annual visit by a national regulator. This approach is an instance of bad cybernetics.

This case illustrates the need to guide a desirable unfolding of complexity for child services in the country, thus strengthening the autonomy of child services and improving their chances of reflexive interactions and value co-creation with organised groups in the community. This

case illustrates that beyond increasing agents' capabilities it is necessary to guide self-organisation from the global to the local for a better policy performance.

Case 2 Structural Recursion and Value Co-creation

Trident

This vignette illustrates the link between autonomy and reflexivity. It argues that failure to develop autonomy within an enterprise reduces its chances for recurrent communications and value co-creation with customers and limits its growth capabilities.

Trident is a small metal-mechanic enterprise in England (Espejo 2012). The focus of this vignette is Trident's interactions with its market.

Years back its management had been aware of the advantages of fostering autonomous actors within the company and had decided to implement *autonomous business accounts* and *cells* within each of these accounts. When an enterprise succeeds producing a recursive organisation, de facto autonomous units are operating in interaction with environmental agents at several structural levels. Each operationally closed autonomous actor creates its own cognitive domain different to that of the organisational system they are part of. They construct their own problems and develop their own problem solving capabilities. They have self-reference and reflexivity.

Autonomous units amplify the enterprise´s problem solving capabilities in the market but also experience more complexity in their communications with other actors in the organisation. Hierarchical impositions are not acceptable any longer; autonomous actors absorb environmental disturbances and control their operations within themselves. They experience exchanges with other actors as disturbances that need accommodation in their own realities, increasing the risk of significant communication gaps between them.

As *autonomous units* Trident and its business accounts and cells needed recurrent interactions with customers to develop their business. Structural couplings[9] (Maturana, 2002) were necessary between Trident and its global markets, between *business accounts* and customers and between cells and related agents' operations. Interviews were carried out with people of these units to establish whether they were operationally closed. Were their recurrent interactions non-hierarchical? Were these interactions providing cohesion, identity and self-reference? Trident's autonomy was not in doubt; the company was responsible for its decisions and viability, the doubt was with its business accounts and cells. Inquiries about interactions among actors confirmed that *within* Trident communications were hierarchical; strategic decisions for *business accounts and cells* were made at the corporate level, confirming their lack of autonomy. There was no structural recursion within Trident.

This meant that communications were between Trident's corporate actors and customers at the expense of autonomous communications between *business accounts* and customers and

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[9] Maturana and Varela (1992: 75) write "we speak of structural coupling whenever there is a history of recurrent interactions leading to the structural congruence between two (or more) systems.".

cells and agents' operations. Trident was preventing autonomous accounts and cells co-creation value with agents' operations. Achieving accounts' and cells' autonomy would have implied an organisational system with distributed cognitive capacity, managing far more complexity than an enterprise lacking structural recursion. But, structural recursion would have made necessary more demanding communications between Trident's corporate actors and business accounts' and cells' actors going beyond hierarchical communications. In the end they settled for hierarchical relationships that made very difficult if not impossible the amplification of additional cognitive domains.

The implications of weak relationships between business accounts/cells and customers were significant. Tridents' products were not the outcome of accounts and cells value co-creation with agents. Demand and product supply were the outcome of unilateral customer requirements. Indeed, better communications were necessary to produce creative meanings for their products. But, however much company senior managers wanted to develop rich interactions with customers they had many other problems to deal with. It was apparent that clarifying meanings in both directions requires more than one-off, occasional, interactions. These clarifications require *recurrent* interactions at several structural levels. As said before, communication is a process of *structural couplings* between actors and agents. This requires crossing each other's boundaries; clarifying purposes and understanding utterances. These are demanding processes that require time and dedication. Among other aspects a *good communication*, beyond transmitting information, is the outcome of a history that requires efforts to see eye-to-eye and develop mutual understandings.

Whenever communications are maintained mutual adjustments and learning are happening in one form or another; this is the outcome of self-organisation. The implications of adjustments and learning are particularly important for the relationship between customers and actors. Trident's account managers were neither creatively challenging customers nor customers were *stretching* them. There was no evidence that in the eyes of customers the accounts were co-creating value with them. Equally there was no evidence that accounts had conversations with customers beyond contacts with their buyers at the expense of communications with planners and managers to learn about customers' programmes and problems.

Trident had two business accounts and 10 production cells; in the end the chances for identity and self-reference and for reflexivity and value co-creation was dominated by corporate managers at the expense of business accounts and cells without identity and reflexivity, something that was reflected in their performance. Their viability was sustained by responding as sub-contractors to customers bringing their own designs rather than as innovators of new products as they desired. Their profitability was marginal and size had stayed unchanged over decades.

Case 3: Energy Producers as Markets of Energy Technology Enterprises

The Value of Sharing a Policy Framework
This vignette illustrates aspects of unclear boundary judgements and self-reference within an organisational system.

In any country multiple companies, institutions, institutional parts and people contribute to its energy organisational system. This vignette shows the value of having autonomous enterprises developing energy technology as non-autonomous actors in the energy production system. The boundary problem is whether to keep them outside of the energy production system or to bring them in. This is an issue of identity and self-reference; do policy-makers want an energy system accountable to the ecological concerns of final stakeholders and customers or not? How are they prepared to answer the question: is energy technology development part of the energy production system or a viable system in its own right?

In a world threaten by climate change a major challenge is adopting clean energy technologies. The question is which type of relations between energy consumers, energy producers and energy technology developers is most likely to support socially responsible technology learning. In particular, who are customers for those developing new technologies? (Espejo, 2014b)

One option is making energy *producers* the markets for technology development enterprises (cf. IEA 2003) another is making energy *users* the markets. The first option puts the emphasis in learning by doing; energy producers deploy new technologies as they buy them and through market preferences give more chances to particular technologies. This option keeps within energy development enterprises learning by searching. This option fragments learning as it restricts the influence of final energy users in energy technology development and reduces the flexibility of adjusting technologies to local conditions. When energy producers are the markets for energy technology developers the learning of the embedded autonomous units within the energy system is not integrated with the on-going technology innovations that are happening outside the system. The challenge is structuring less constraining learning mechanisms.

To support our discussion I'll focus on the wind energy sector, whose development depends on the contributions of different types of enterprises, some of them doing exclusively R&D, others mainly deploying technology, others producing energy and so forth. Should these enterprises be autonomous or non-autonomous units? In the end, as I explain below, this is a policy decision.

In the wind energy system only those producing wind energy for final customers should be autonomous. These are units aligned with the sector's purpose, which amplify its complexity through their autonomous performance. Those enterprises doing research and R&D are contributing to the sector's innovation (its intelligence function) and therefore should not be autonomous, *but often they are large enterprises with purposes different to energy production*; their performance relates to innovation and product deployment and not to energy use. This approach fragments doing and searching. This is in contrast to integrating *energy producing and technology development in a recursive wind energy organisational system*; this offers the possibility of learning by doing and searching at several structural levels. A recursive structure, if properly implemented, has distributed governance; each autonomous actor –sector, enterprise, plant and more- has its own capacity for creating,

regulating and producing aligned policies within the sector. Each autonomous actor has self-reference and reflexivity.

Considering that investment for energy technology often goes beyond the possibilities of individual enterprises, technology developers need funding from the public purse and consumers [through prices] and therefore should be aligned with the viability of the energy producing system and accountable to public energy stakeholders. The values of producers and stakeholders should be transparent to policy-makers and influence together with expert opinion their decisions (Espejo, 2014b). It is necessary increasing the stretching power of both regular customers and vociferous stakeholders as well as guiding the structural development of a largely self-organising wind energy sector. Together customers' stretching energy producers and vociferous stakeholders' stretching new technology developments should shape policy-making.

From a learning perspective, making wind technology enterprises businesses in their own right is a boundary judgment with significant implications for them; as independent businesses, rather than as R&D components of an energy system, their customers are energy enterprises buying and deploying their technology (e.g. turbines). Their relations with these enterprises are commercial. The final energy user is decoupled from them, thus making it less likely that their decisions and learning will take into account the *social* and *ecological* implications of exploiting wind technology. Additionally, they are decoupled of recursive policy processes within the wind sector reducing the chances for more focused innovation and change. Independent R&D enterprises increase their distance from energy consumers and reduce opportunities for integrated *learning by searching* and *learning by doing* at several recursion levels. Their learning will be driven by corporate commercial values, rather than by doing and searching driven by social, ecological and commercial values at all structural levels. Policy-makers fail to close a technology development learning loop with final customers and thus make *weaker the energy technology learning*.

On the other hand, as R&D components of the wind energy system they share with energy producers the same energy wind *policy framework* and therefore the chances of a stronger alignment with energy consumers. In this latter case resources for technology development can contribute to innovative energy production at several local levels of recursion. Energy producers' management (i.e. the sector's cohesion function) and R&D resources (instances of their intelligence function) would be monitored by *policy-makers* in the search for policy options from the global to the local. For an effective learning R&D wind turbine enterprises and energy producers should operate under the same policy framework. Their learning is grounded at the same time in the sector's doing and searching.

Bringing energy technology enterprises within the energy system and sharing a policy framework helps resourcing innovation recursively and improving the recursive checks and balances of deployment enterprises. These structural changes should make more robust technology learning. The performance of the wind energy organisational system will be the outcome of guided self-organisation between the energy system and stakeholders (energy users) at several recursions. In this context producing energy is accepted as the purpose of

the wind turbine enterprises and improving communications between them and the sector's management as a platform for improving communications between policy-makers and stakeholders. These are mechanisms for self-reference and for value co-creation between the wind energy sector and stakeholders.

Case 4 The Economy as an Organisational System

Constituting dysfunctional autonomous roles: the 2008 Financial Crisis

The economy is largely self-organising; the market plays a significant role in this process. It is constituted by numerous agents striving for their viability. In this context it is natural to find all forms of cooperation and competition, but, unfortunately, in the end the problem is an economy extracting wealth in the benefit of the powerful few at the expense of the wellbeing of the most. It is in this overwhelmingly competitive jungle that self-organisation constitutes autonomous roles, producing the goods and services demanded by the market, and non-autonomous roles, creating and regulating policies. This distinction is not always clear to policy-makers in society at the cost of people and organisations, as illustrated by the 2008 financial crisis. It is necessary guiding self-organisation to avoid dysfunctionality.

Risk management is necessary to reduce the consequences of failure. In a forest a forester response to the trade-off between high yield and possible fires is building *fire breaks* constraining connectivity between the trees; these were the safety breaks - structural constraints- that the regulators of the economic and financial systems failed to visualise before the 2008 financial crisis and unfortunately it would appear are still failing to appreciate (Haldane and May 2011).

From their own accounts economists failed to understand that small changes in one part of the financial system could produce catastrophic effects elsewhere; the butterfly flapping its wings in the Amazons producing a storm in New York. They thought that each banking institution could contain its problems, failing to see the non-linearity of the financial system. Policy-makers and economist failed to see the strong connectivity of financial services, in particular of derivatives leveraging several times over their capital across the globe. Rather than containing the fire in individual banks the situation was a financial ecosystem catastrophe. Banks were effectively global banks that affected the global economy; these banks 'were too big to fail'.

Policy-makers failed to see that finance is a service to the economy rather than an autonomous system in the market. The complexity unfolding of financial services into financial services at the regional, country and local levels was fragmenting the economies at all these levels. It can be argued that the domino effect experienced in 2008 was more than a systemic failure of the financial system; it was an economic failure. The big, global, banks were operating, and still are, largely weakly coupled to national, regional and local economic systems. The financial system didn't see that their autonomy had to be constrained by the economic realities at all levels. The fact that before 2008 they leveraged assets several times over capital made apparent that their purpose was making money and not economies viable.

In fact, in the UK, the growth of financial instruments before the crisis outpaced three times the growth of the economy (Haldane and May, 2011). The UK was both extracting wealth from the rest of the world and fragmenting their economic activities.

Effective complexity unfolding implies successful viable countries, cities, regions and localities. These systemic levels emerge from self-organisation; whenever the regulator, in this case the mechanisms of governance, overreaches its regulatory capacity a new structural level is necessary. The problem is avoiding unfair extraction of wealth from the powerless and enabling non fragmented social and economic units with their own regulatory capabilities. These regulatory capabilities should be structural constrains that at the same time of enabling autonomy and variety amplification create barriers between autonomous actors. This is a strategy to manage the huge complexity emerging from the global connectedness of billions of people; aiming at autonomous units with high inner connectivity at the same time of being weakly related to other autonomous units themselves with high inner connectivity is good cybernetics (Espejo, 2013). By containing complexity through autonomous systems the strategy is adding resilience to the economic system; regulation is just that that is necessary to enable the cohesion of autonomous but not independent systems. Market economies often misunderstand this strategy; free for all is a strategy blind to social connectivity. Rather than the weakly regulated global financial services extracting resources for the wellbeing of powerful nations and few bankers, the 2008 crisis could have been ameliorated by banking activities with a stronger connectivity to local economies. Evidence supporting this argument is the better performance during the crises of economies like the German, where smaller local banks are common, compared to more financially oriented economies. For instance in the UK, where small banks are less common, decoupling retail and investment financial activities has proved far more difficult, even if recognised as necessary. It is necessary to address the risks of the economy beyond financial activities.

It appears that for Haldane and May addressing risk at the systemic level would have implied tinkering with retail and 'casino' (investment) banking. The UK government wanted improving financial structures, especially among institutions deemed 'too big to fail'. Though breaking banks this way may help reducing risk, it does not address the need for financial services as non-autonomous services distributed in the economy. *Still there is the view of banks as businesses pursuing their own purposes rather than those of their related economic systems*. At the national level the organisation of the economy (as an organisational system) continues to be driven by blind fragmentation and not by the wellbeing of the people. Accepting finance as autonomous is fragmenting the economy dangerously; it is accepting working for the viability of financial institutions rather than for the viability of the economies they are supposed to serve. Constrains have to be placed encompassing financial services within social and economic organisational systems. This is a means of regulating unrestricted wealth extracting. To limit risks, and restrict the diffusion of failure, large and small banks need to work out their embedding in the several levels of the economic system; the German system with small banks gives more stability to the economy and decouples risks for smaller banks from larger ones.

My argument is for distributed regulation of the economic activities. Cyberneticaly a good regulator of a system is a model of that system (Conant and Ashby, 1970). Financial services should be regulators of the economy, and following Conant and Ashby, good regulation should map the economy's unfolding of complexity from the global to the local; economic aspects should intertwine with financial aspects at all structural levels under the umbrella of the economic system. Furthermore, the strategy of structurally large financial services, that is, financial services dominated by large international banks, located in financial centres like New York, London or Frankfurt and in their turn regulated by centralised regulators like the Federal Reserve, the Bank of England or the European Central Bank, is dangerous. Tough this structural arrangement appears to accept finance as a service it lacks requisite variety for the very same reasons that led to the 2008 financial crises; global banking assumes a global integrated economy that is not the case and the large interconnectivity of financial services fails to guide the need for strong economic structural recursion. This is particularly relevant for the world´s weaker economies. This tacit institutional arrangement strengthens the fragmentation of the global economy. Accepting that it is a tall order, decentralisation of financial services and financial regulation should be beneficial to the global economy in the longer run.

To summarise, if agents that should not be autonomous become autonomous at a global scale and therefore dysfunctional to the global economy, their policies, often driven by greed at the expense of local people, imply un-guided self-organisation from the global to the local. This increases the chances that small undesirable local changes will threaten not only local viability but the viability of the non-guided larger self-organised system. In other words, a small addition of risk may produce a big unexpected change as the system reaches its self-organised criticality: "a single sub-prime grain produced the self-organised criticality of the financial sector" (Haldane and Nelson, 2012) and challenge the stability of the whole economy. Without building appropriate 'walls' within the system crises may spread rapidly throughout.

Coda

The Cybernetics of Policy Processes

This contribution has been about the cybernetics of policy processes. Social policies have been presented as catalysts for the self-organisation of varied resources to create, regulate and produce these policies. As these resources come together they produce organisational systems and the Viable System Model is a heuristic to guide self-organising processes. This model offers criteria to speed up desirable self-organisation and to diagnose problems in policy creation, regulation and production. In few words my concern here has been studying and highlighting the cybernetics of problematic situation. How is it that they failed the test of good cybernetics? No attempt has been made to improve them.

The first vignette highlighted a common occurrence in policy processes; policy-makers are often unaware of their cybernetics. Confronting a problem situation, like in this case failure in child care, requires enacting a policy and providing resources. However, at the core of all this

is improving relations among institutional actors and between these and stakeholders; what are the communication requirements to achieve good value co-production between actors and agents. I have argued that guided self-organisation is necessary and that his is offered by the Viable System Model as well as by self-reference and reflexivity.

The emphasis of the second vignette was in autonomy and value co-production. The case shows that failing to enable autonomous cognitive domains within Trident, capable of observing and participating in the relations between business accounts/cells and customers makes marketing relations weaker and reduces the company to a sub-constructing business which inhibits innovation. Conceptually the vignette highlights reflexivity; for powerful interactions producers and customers have to offer value propositions to each other overriding the offerings of "objective" products and "objective" requests.

The third vignette highlighted the need to question the identity of the energy system. It was argued that the identity-in-use for the energy system was one that left out the energy technology development enterprises and this identity increased the risk of fragmented learning by doing and learning by searching, inconsistent with the espoused theory of an integrated energy system operating under the same policy framework. Self-reference was necessary to clarify identity and systemic boundaries.

The last vignette implied the need of guided self-organisation to change dysfunctional market relationships. As the connectivity of the global economy increases -the case in the past few decades- the market's invisible hand has fuelled the risk of uncontrolled economic failure. Economists need to understand the ramping complexity of this global economy, which today more than ever before, includes social and ecological imperatives. In particular they need to understand that guided self-organisation implies a recursive social system that avoids an unfair extraction of wealth from the less well-off countries and more than that, that avoids in all countries the extraction of wealth from the less well-off citizens, something which fuels injustice and social conflicts.

Good social cybernetics is a must in policy processes.

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