PATTERNS THAT CONNECT: EXPLORING THE POTENTIAL OF PATTERNS AND PATTERN LANGUAGES IN SYSTEMIC INTERVENTIONS TOWARDS REALIZING SUSTAINABLE FUTURES

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"On each continent and in each nation one can find creative bubbling, a multitude of political initiatives in the direction of economic, social, political, cognitive, educational, ethical or existential regeneration. But everything that must be connected is yet dispersed, fragmented, separated. These initiatives are not aware of each other, no institution enumerates them, and no one is familiar with them. They are nonetheless the breeding stock for the future. It is now a matter of recognizing, aggregating, enlisting them in order to open up transformational paths. These multiple paths, jointly developing, will intermesh to form a new Path which will decompose the path we are following, and which will guide us toward the still invisible and inconceivable metamorphosis." (Morin, 2011, p34)

ABSTRACT

Working towards more sustainable systems is a critical endeavor of the 21st century requiring collaborative efforts for the broad development of systemic literacy. This paper explores the potential of patterns and pattern languages as tools for systemic change and transdisciplinary collaboration, investigation and design, and outlines the ways they could be further operationalized to develop and leverage collective intelligence and agency towards Curating the Emergence of Thrivability and Realizing Sustainable Futures in Socio-Ecological Systems.

Considering patterns and pattern languages, social organization, and systemic change from a variety of perspectives, the author suggests that the concept of pattern has an unfulfilled potential as cognitive technology for meaning-making, mediation, systemic configuration and exchange of knowledge, both within and across domains of human activity. In particular, patterns have properties that could help address the unity versus diversity dilemma while dealing with complex challenges.

Rather than giving a complete theoretical review of the field of transdisciplinarity and systemic change, the paper sets key elements of the context and investigates possibilities and directions for future work. Starting with an outline of the nature and dimensions of the complexity challenges the world is faced with from a systemic and cybernetic perspective, the paper explores the versatile properties and functions of patterns and shows how they could help conceive and develop a whole family of tools for systemic focus, interpretation and connectivity. Finally, it presents possibilities of applications of pattern-based approaches in transdisciplinary intervention contexts, using patterns as boundary objects to bring into focus different dimensions of complexity.

Keywords: complex systems, patterns, pattern languages, systems literacy, critical systems thinking

PHILOSOPHICAL AND THEORETICAL BACKGROUND

The challenges of complex systems

The systemic sustainability challenges our societies are faced with today fall typically in the wicked problem category (Rittel & Weber, 1973), which is of a complex nature. Complex systems are shaped by loosely interconnected influences distributed within 'wider contexts', that run at different paces and interdependently coevolve, with effects that manifest at levels and scales other than the ones they originate from. They arise at the interplay of natural phenomena and human action, and are affected by a diversity of power relations and structural dynamics, which may take a life of their own (Heylighen, 2008).

Alongside the acceleration in the outbreak and strength of fast spreading phenomena, often spectacular, which directly affect people's livelihoods and wellbeing such as global financial crisis, regional conflicts or ever more powerful hurricanes, slower less visible processes are producing irreversible bio-physical shifts such as greenhouse effect, water scarcity or soil erosion. Systems sciences are able to provide some understanding of how phenomena propagate and evidence of long-term shifts as well as directions for the design of socio-technological responses. This evidence however is often fragmented, in particular when social and techno-social dynamics interfere with natural biophysical phenomena, increasing levels of uncertainty and unpredictability. Constructive responses may result locally from technology and innovation, but these may also aggravate existing problems or create new ones. A remedy may with time indeed turn into a poison (Bateson, 1979; Stiegler, 2013), and there are no possibilities to undertake broad preliminary 'clinical tests' of envisioned solutions in large open complex systems. Debates about geo-engineering are an illustration. Together with a need to collectively make sense of the dynamics at play in our socio-technological and socio-ecological systems and integrate their different dimensions, there is a 'pharmacological' aspect (Stiegler, 2013) to account for in systemic interventions, which is often neglected. This pharmacological aspect requires the on-going evaluation of the socio-technological systems we build. In particular, the transformation of their behaviors and the evolution of their systemic effects on socio-ecological systems must be probed over time, to ensure their continuous health, and therefore sustainability.

The challenge we are faced with is that the factors affecting the trajectories of complex systems and their sustainability through time are of multiple nature, multidimensional, distributed, and co-evolving. So are the leverage points, the knowledge/expertise and the agency necessary to evaluate and respond. At the same time, knowledge grows at a pace that makes it increasingly difficult to process, integrate and grasp as a whole (Heylighen, 1999; Pendleton-Jullian, 2015). Whether we place ourselves in the socio-political realm which underpins social action or in the scientific/expert one which informs it, there are no central venture points or higher orders to be found from which to process information, to aggregate knowledge and/or to design grand plans to act upon evidence and circumscribe wicked problems in order to intervene 'globally', in 'one piece' or 'as a whole' on the wider system. This can only be done from multiple centers, leveraging the distributed agency of multiple and diverse change agents towards sustainable and thrivable futures (Morin, 2011).

Collective agency in complex systems

Action itself is the result of individual and social processes of communication and co-individuation, forming complex living cognitive systems. People gather by affinity in communities of action or practice around social objects, i.e. the 'objects' upon which they choose to focus their caring attention and efforts, the 'causes' they espouse, which may be of different natures (for example related to people, places, issues, knowledge, resources, processes, or desired outcomes). These social objects act as attractors and centers of shared visions, values, goals, and action. They are the nodes around which common experiences, languages, cultures, praxis, and the resulting knowledge and know-how are shaped. They provide the context and the content for the processes by which individual and collective identities are constructed, transformed, and differentiated in relation to each other and to the forces that hold people together, that which Husserl and Habermas called *lifeworlds* (Gregory, 1996). These clusters of cooperating agents and specialized agency constitute the living cognitive systems, which together form 'society' (Veitas & Weinbaum, 2015). Patterns are involved in multiple ways here, as we will see further in the paper.

We can picture these clusters, internally bound by strong forces, each directly catering to or strongly influencing a specific part or aspect of a wider complex system through the activities they conduct around their dedicated social objects. Externally they are inter-related by loose forces, and they directly or indirectly influence each other and their environment through the effects resulting from aggregated behaviors that emerge at various levels and scales. This means in other words that socio-technological and socio-ecological systems do not operate independently from the communities (i.e. living cognitive systems or socio-cognitive systems) that attend to, interact with and/or influence them.

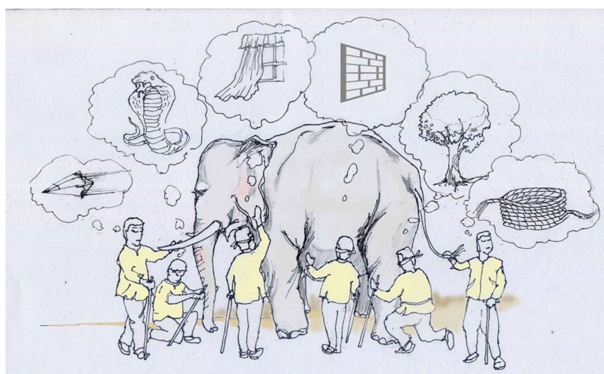

Figure 1. The Ancient Indian Fable of the Blind Men and the Elephant[1]

As a result of these 'multi-centripetal' social group-structuring processes, angles of approach and types of responses are multiple among change agents. Differences in paradigms, perspectives and processing modes influence the points of entry into issues, the 'direction' of the processes involved, the types of outcomes sought out, and the types and levels of intervention. What people say needs to change, or the types of change they support, advocate or engage in, amount to a whole universe of possibilities!

Unity in Diversity: the paradox

When it comes to seek coherence of transformative approaches at the global aggregated level, we are faced with the paradox that a diversity of focus in knowledges, know-hows and approaches to change available to address wicked problems is at the same time a necessity and an impediment.

It is a necessity for two reasons. First, because focus is a condition for agents to achieve the goal-directed and efficiency-seeking strategies they prioritize and choose to allocate resources and efforts towards: a driver for agency. Goals and priorities indeed are not 'interchangeable' as they are paradigm and preference dependent (Meadows, 1997; Brown, 2005; Finidori, 2013). Second, because the variety and distribution of points of

[1] Original Text <http://bit.ly/1ymh1su > Image: http://blog.practicalsanskrit.com

focus and forms of efficiencies at multiple localities act as multiple distributed leverage points and provide a rich and resilient polycentric basis (an ecology for transformative action) from which coherent systemic change may eventually occur, as an emergent outcome of aggregate agency (Morin, 2011; Finidori, 2014a).

Focus which entails specialization is an impediment however for two reasons. First because frameworks of focused efficiency-seeking action which create natural boundaries around clusters of cooperation and specialization, become 'exclusive' of alternative frameworks. As all clusters have different understandings and opinions about the challenges the world is facing and the ways to address them, each tries to convince others that they hold the best solutions and methodologies trying to 'funnel' other solutions through their perspective. This hinders relational dynamics and agents' capacity to collaborate across groups outside of their domains of action. We end up with a multiplication of islands of knowledge and know-how, each with domain specific cultures and languages and their own views of reality and how it unfolds, each operating with different sets of patterns (more or less explicit). Second because continuous maximization of efficiency-seeking strategies (repeated positive action feedbacks generating accumulations) applied on parts of a system, without information feedback from other parts and attention to inflection points, may generate local fragility and unintended consequences on the whole system, even when they are 'well meaning' and sustainability oriented (Finidori, 2014b).

The increase of inter-dependencies and possible 'causes' which characterize complexity is met with increased specialization, and therefore with an increase in the variety and differentiation of responses. The greater the specialization (i.e. reduction at local levels), the greater the fragmentation of knowledge and the competition and potential incommensurability between approaches (at global levels), and the greater the disconnect in which, seen from a broader systemic perspective, change agents operate. This is somewhat in contradiction with what seems to be an increasing strive to cooperate and coordinate responses.

In addition to the above, the multiplication of the types and volume of knowledge and opinions that flourish in multiple media are increasingly difficult to 'humanly' process and curate to support the collective tackling of global issues. Growth of human knowledge in its various forms (content, contexts, and representations) and its differentiation are not matched by an equal degree of integration[2] (Heylighen, 1999), which would ensure its widespread coherence and 'actionability'.

The result is a fragmented ability to identify and address the multiple dimensions and factors of complex systemic challenges and to consciously bring into relation (if not reconcile) the various facets of and approaches to systemic change, while making the best use of existing knowledge. This fragmentation makes it increasingly difficult to resolve conflicting perspectives, to find coherence, and to coordinate action across boundaries. What is needed is

Working across approaches – where are we at?

Many approaches have been developed to work across disciplines and paradigms (Frodeman et al., 2010; Cronin, 2008; Griffin et al., 2005)[3]. In the area of systems sciences

[2] Heylighen calls *differentiation* the process of increase of variety, and *integration* the process of increase in the number or strength of connections.

[3] I can only be very brief here, to set the main elements of the context, without entering into a complete review of the work in this area and its applications. One may also note among others the toolbox project <http://bit.ly/28Zhghw>, the 'Science of Team Science' project < http://bit.ly/29dUAwC >.

and critical systems thinking in particular[4], Jackson (1987) and Flood (1989) introduced the concept of methodological pluralism aimed at addressing new types of questions through the proactive and reflective integration of paradigm and methodology diversity in systemic interventions. Methodological pluralism contrasts with approaches framed as isolationist (prescriptive of the beholders' exclusive 'best way'), imperialist (which coopts competing ideas) and pragmatist (based on trial and error and what 'works' in practice regardless of epistemological underpinnings) (Jackson 1987). As most transdisciplinary endeavors, Flood and Jackson's pluralism (1991) is essentially consensus-based and meta-paradigmatic (operating above paradigms), which raises a certain number of questions as far as working across incommensurability, or in other words achieving unity in diversity, is concerned. Jackson himself (1990, in Gregory, 1996) emitted doubts that 'one pluralist approach' that would overarch other approaches could be met.

For Gregory (1996) and Midgley (2000), consensus based and meta-paradigmatic forms of pluralism can easily 'slip' into imperialism. Gregory argues that in consensus seeking contexts, dominant 'force fields'[5] are in a position to absorb weaker, newer ones, as certain forms of inquiry can orient outcomes towards existing orders. This position is akin to Baudrillard suggesting that dissent is bound to be diluted in the dominating 'code'. For Midgley, the view of pluralism proposed by Jackson and Flood defies the idea of pluralism, as it seeks to integrate diversity within one overarching framework, and to define the contexts in which specific methodologies can be used: an imperialist endeavor. This underlines the need for a critical approach to the various forms of pluralism and their implications.

The 'slippage' is found in practice, where attempts to organize coordinated responses to global challenges and unite forces 'across islands' are often associated with ideals of shared vision and discourse, and with attempts to align on common priorities and pathways, which may be prescriptive and normative (one size fits all). The large open discussions I moderated or attended, with objectives to coordinate action and establish common agendas through debate and consensus, are an illustration[6]. And so are the attempts of self-organized activist movements such as Occupy in the US, the Indignados in Spain, or Nuit Debout in France with respect to being able to understand each other across perspectives or to resist being co-opted by groups with more specific agendas; and at global scales, the need of institutional level initiatives such as the Sustainable Development Goals (SDGs) for viable collaborative frameworks that can help deliver the goals, including a coordinated global research capacity, and conscious strategies to link up and co-create new ways forward (Cornell & Parker, 2013).

The systemic processes of fragmentation and reduction, and their risks of slippage towards 'isolationism' or 'imperialism' as described above, are at work in all types of cognitive systems, whether among scientific communities, social change movements or activists, or public policy institutions, and other types of communities of practice such as economic, spiritual etc.

Focus and connectivity towards coherent emergent outcomes

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[4] Critical Systems Thinking strives to take a critical approach to solving complex systemic issues, through inquiry on systems boundaries and combination of different systems approaches.

[5] Gregory defines a force field as an area with points randomly scattered that are either positively or negatively charged. The charge of the field can be altered when a 'power' is applied to it to modify its order. One can consider the maximization of effectiveness seeking strategies through positive feedback loops as mentioned above as an applied power.

[6] I refer here in particular to a discussion I launched and moderated on LinkedIn Systems Thinking World group which lasted for 3 years and generated almost 8000 comments, and led to much of the research on ecology for transformative action I am pursuing now.

Transdisciplinary or multistakeholder interventions towards coherent emergent outcomes, rather than fusing identities, require bringing together different fields or clusters of interdisciplinary interest into more constructive relationships, in mutual recognition and appreciation of respective positions (Midgley, 2000; Gregory, 1996; Finidori, 2013, 2014). How then can possibly divergent and conflicting 'forces' be brought into relationship?

To the idea of force field, which seeks to produce unity by diluting diversity, Gregory (1996) opposes the idea of 'constellation', federative of diversity. Constellation brings into relationship and contrast various possibly discordant positions, so that identities can be preserved and dialectical reconciliations avoided.

The two concepts need not be opposed however, as various force fields can coexist in constellations and complement each other in action, generating unity through coherence in their outcomes or effects. Forces resulting from action are natural components of systems: the definition of 'work'. They are not necessarily imperialistic in their intention, the key issue is to be able to identify these forces and monitor their relationships and dynamics.

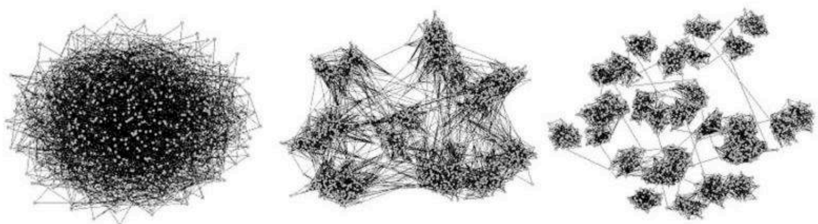

Figure 2. Interconnection and boundaries (Centola, 2015)

Differentiated centers of focus/action and integrative connectivity among them are both needed to ensure local pertinence and coherent global outcomes. A recent study (Centola, 2015) shows that clusters in a network are more permeable to diffusion of ideas and change when they are interconnected AND when they have moderate boundaries. What must be avoided are isolated islands or totalized homogeneity. Interconnections create opportunities for interaction and cross-pollination among clusters. When clusters have sufficient boundaries (i.e. are cohesive), ideas can circulate and be adopted more easily and faster, allowing for agents to co-evolve and for networks to innovate both locally and globally. This applies to transdisciplinary approaches to sustainable futures as well.

Achieving unity (coherence of emergent outcomes) in diversity (multiple centers) towards the realization of sustainable thrivable futures requires ways to open up bridges among different clusters and forms of knowledge and action, and to collectively curate the emergence and convergence of thrivable sustainable outcomes.

Systemic literacy must be advanced to take into account how systems actually work, and how change actually occurs, not only in their 'mechanical' espects, but also in their political, philosophical, psychological, emotional, existential, relational, anthropological, epistemological dimensions (Smith, 2015; Parker, 2014). The connective and distributive power of our technological intelligence must be matched by the development of a relational intelligence and systemic consciousness (Laszlo, 2015). This involves a set of 'sensing' and mediating capabilities and tools to (1) make sense of salient patterns and weak signals in growing volumes of information and knowledge, and (2) leverage agency and the complementarity of perspectives, knowledges and know-hows across the board, and help change agents to enter in *syntony* with each other and their environment (Laszlo, 2015), i.e. to inter-operate from where they are located, with an eye on what is around and the evolving whole.

Integrating the various dimensions of complexity

With such a fragmentation of knowledge and approaches to action, how then can the interconnection of multidimensional factors of complexity in their systemic dynamics and implications be interrogated and tackled?

When it comes to the study of complex systemic phenomena and dynamics, whether we believe or not that reality is objective and can be modeled, or that decisions and policy must be made evidence-based, there are subjective and inter-subjective components, as well as cognitive processes, at the individual and group levels, which affect outcomes, adding some dimensions to hard scientific evidence and our predictive capacities[7]. It is therefore very difficult to generate traditional forms of 'evidence-based policy' from complexity science.

Alongside scientific-objective evidence and its justification (what to do, and for which logical reason), there are psycho-cognitive and social-cognitive (or cultural) matters to consider, which, whether we like it (or hold it as 'true') or not, come in the way and affect systemic interventions and initiatives for change. This applies to all domains.

Alternatively, relying exclusively on soft approaches and human dynamics and ignoring hard scientific evidence may leave critical components out of the picture. Subjective psycho-cognitive and social-cognitive dimensions are closely intertwined with scientific-objective ones to produce emergent effects in socio-technological and socio-ecological complexity.

Finding ways to discern (1) the scientific-objective, (2) the psycho-cognitive, and (3) the social-cognitive dimensions of complexity is essential, in particular to recognize, alongside scientific foundations, the importance of psycho-cognitive drivers and identities, social-cognitive framings of meaning and power relations, and to reflect upon (4) the interconnectivity and inter-relatedness of these systemic factors, and that which emerges as a result, including relationships to the world and the cosmos. How these dimensions are taken into account and integrated in systemic interventions may affect the effectiveness and outcomes of applied agency.

All too often, these dimensions or the epistemologies that underpin them are deemed incommensurable, and therefore dealt with in isolation if not in competition. Practitioners limit themselves to one of dimensions as their prioritized field or angle of intervention[8]. Many argue that there is no need for competition or collective prioritization of approaches or to elect a camp. Reconciling hard and soft thinking in systems interventions, for example, has been one of the key endeavors of *System of Systems Methodologies* (Jackson & Keys, 1984), and its evolution into *Total Systems Intervention* (Jackson & Flood, 1991), and is at the origin of the development of Critical Systems Thinking. *Total system intervention* as framework for choosing and combining methodologies, maps problem-solving methodologies to problem-situation and types of relationships between participants. Such categorization does not necessarily reflect the reality of situations or the complexity of the problem context. In contrast, the *Cynefin* model (Kurtz & Snowden, 2003) is a sense-making framework to adjust response processes to the complexity of contexts and situations. As an alternative to *Total Systems Intervention*, Midgley (1997, 2000) proposes a custom *Creative design of methods*

[7] The fact 70% of organizational change initiatives fail because of human rather than objective factors is an illustration: McKinsey report <http://bit.ly/1OgXvAq> [retrieved 15 May 2016].

[8] There are many frameworks through which dimensions of complexity and points of entry into change interventions can be studied. See for example Bennett, J.G. (1963), and the adaptations of action logics to change in Finidori (2014c).

approach, based on synergies of methods adapted to the 'multi-layered' aspect of local contexts, which enables different moments of inquiry in the course of interventions. These moments correspond to different epistemologies and ontologies, to different levels or dimensions of analysis, which can be interconnected in multiple ways according to the context.

The pattern language approach to systemic transformation suggested in this paper seeks to 'tool' sense-making frameworks and new forms of method combination in order to interconnect and enable navigation across dimensions of complexity and such moments of inquiry.

The cybernetic orders perspective

Looking at systems from a cybernetic perspective can help adopt an inclusive view while accommodating and revealing to each other different dimensions of complexity including a diversity of identities and social-cognitive framings: a necessary stage for further differentiations and interconnections to become visible.

Cybernetics has conventionally been divided into first and second orders. With new developments around social cybernetics, what was traditionally encompassed under second order is currently being further divided into additional orders to accommodate new dimensions of analysis. We are now seeing some literature florish around third and fourth order cybernetics (Mancilla, 2011, 2013; Wood[9]) and beyond (Yolles & Fink, 2014; Judge, 2007, 2015), with varying definitions/descriptions, although third order cybernetics now tends to stabilize. I will describe my understanding of these orders and outline how they can help systemic analysis in the coming paragraphs[10].

Navigating through cybernetic orders, enables the integration of the four dimensions of complexity described above (scientific-objective, psycho-cognitive, social-cognitive and systemic-emergent) by successively drawing boundaries in ways that change the frame of reference or how we look at things while adding new perspectives and uncovering new interactions, enabling the modeling (and simplification) of greater complexity, without leaving anything out (Yolles & Fink, 2014; Judge, 2015). Perspectives are no longer seen as epistemologically incommensurable, but as complementary facets of the same reality, which can recursively become the subject of better collective sense-making. Adding dimensions becomes a way of taking expanding views of systems and forms of agency, and can be part of a learning and paradigmatic evolution process, which embraces changes of scale while keeping the focus and the capacity to act at each locality.

First order cybernetics embodies the object, phenomenon, situation or system observed, the social object of attention (as described in the first sections of the paper). Associated with logical and/or technical solutions (based on evidence), it answers what (objective) and how (process) questions, and focuses on anticipation and projection. Yolles characterizes first order through the invariant construct of feedback, at the basis of systems dynamics, which explores interconnected networks of objects through their feedback and mutual influences, with intensity vectors that may be simulated. Stafford Beer offers a definition most relevant to our perspective: "*A first order system [is] composed of interactive operational objects that together form a whole, the perception of which is conditioned by a cognitive knowledge-based frame of reference. It is relative to the individual subjectivity of coherent groups that have developed normative perspectives*" (Yolles, 2006, p55).

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[9] I refer here to the work undertaken by John Wood and his team in the Attainable Utopia Project: http://attainable-utopias.org

[10] This will be the object of further research. In particular, I would like to explore how JG Bennett's Systematics and polyads(1963) can be applied here to bring more dimensions to study.

Second order cybernetics introduces the interface with the subjective observer, the frame through which he sees the world. The perception and representation of the object observed is subject- and therefore worldview- or paradigm-dependent. Relativists posit that we each have a different image of reality even when we look at the same object. How do we take into account the different perceptions and interpretations of what is perceived? The different understandings of how science can be applied? Psychological and social cognition factors and their differentiation can be revealed here in the formation of knowledge. Beer defines second order as "*systems that operate through concepts, thinking and beliefs, from which knowledge derives. The local individual or group belief based creation of concepts and their patterns are held in worldviews that establish a frame of reference, and determine what is known and its associated meanings*" (Yolles, 2006, p55)." The observer observing the system, and the subjectivity of the observer in apprehending the system can become first order systems themselves, objects of observation (what and how questions). Observations of the same system, phenomenon, or question from multiple perspectives, as part of a transdisciplinary/transcultural approach or in participatory action research interventions, allow hermeneutical discussion and the confrontation of varieties of knowledges, evidence and understandings. Highlighting difference leads to self-reflexivity.

With third order cybernetics, observers and systems, i.e. subject and object, co-evolve, forming a new system, which co-constructs its future state. Observing the system and seeing ourselves as being part of it influences decisions and the orientation of the system under study, which re-directs itself to adapt to context. This gives rise to a new interactive worldview, as mental beliefs and systemic behaviors are co-related. Through the structures and processes we set up and our behaviors as agents, we shape our systems and our systems shape us in return. Our messages, i.e. the tracks we leave in the system, and the stigmergetic processes[11] these tracks entail are key to co-evolution dynamics. The messages sent (in versatile and therefore ambiguous languages) and interpreted (via variable paradigms) in identical situations (first order) may differ (second order), and therefore orient outcomes in different directions (third order) (Troitzsch, 2010). A key challenge here is that in the short run, the message or track is interpreted or acted upon before it takes effect (sometimes entailing self-fulfilling prophecies). In the long run, the accumulation of tracks and positive feedback may cause the 'medium' to take control (Heylighen, 2008) or the 'structure' to take a life of its own as social-cognitive system itself, with its own agency, exerting an influence beyond the sum of the agency displayed by individual agents (Lenartowicz et al., 2016). Discussions on subject/object/medium and on structure-versus-agency belong to this order of analysis, and so do those on power. This is the level where epistemologies and ethics are discussed, and pharmacological approaches enacted.

Fourth order cybernetics, as I apprehend it[12], focuses on the integration of a system within its larger, co-defining context, and acknowledges the complex system's emergent properties. As such it fully embodies complexity. Multiple heterogeneous first to third order co-evolving systems influence and interact with each other, and with their context, thus co-evolving into systems of a higher order. Effects originating in various localities emerge at higher levels, creating superstructures that can dominate a system and 'immerge' in a feedback loop, to affect lower levels. Because of the wide variety of phenomena arising in different fields, and the many different spatial and temporal scales involved, observation, description, and course of action are an increasingly critical challenge for scientists, not to mention harmonization. When discrete observers can't

[11] Stigmergy is a mechanism of indirect coordination, through the environment, between agents or actions. The principle is that the trace left in the environment by an action stimulates the performance of a next action, by the same or a different agent.
[12] My preferred description being that of Attainable Utopias: <http://bit.ly/29aIR57> [Retrieved 15 May 2015]

draw relevant boundaries, a network of distributed agents could in theory act as a collective 'observer' of a fourth order system (collective intelligence at work), but this requires to integrate the knowledge embodied in the network, and make it actionable. A great challenge to which the development of patterns and pattern language-based technology may provide answers.

Understanding and orienting complex systems requires transdisciplinary/interdisciplinary approaches focusing not only on transversal topics such as complexity, cognition, sustainability, thrivability, global citizenship, or commons, but also approaches which focus on same specific 'what' and 'how' questions (first order) seen from various angles and which explore the intersection among perspectives, and adjacent questions (second order). It needs new types of tools and methods for applied epistemology and ontology, which can help to mediate between paradigms and forms of interventions and understand how they shape systems (third order). It requires the integration of one level and the next, one dimension and the other, slow and fast dynamics; the study of multiple levels of organization at once; and the reconstruction of phenomena and systems dynamics from fragmented, non integrated observations and data using experimental design and hermeneutical interpretation approaches (Chavalarias et al., 2009) (fourth order). Ultimately approaches which combine perspectives from various cybernetic orders are likely to mobilize distributed collective intelligence and agency.

Of course, none of this desirable relational and adaptive processing will be encouraged, maintained or even allowed if the dominant philosophical, political or religious worldview entails a rigid sense of identity and hard boundaries against collaboration with some other group of human agents. This type of approach is necessarily spearheaded by the 'willing', those distributed within 'the system', who strive to change it from where they are located, and to achieve coherence through connectivity with others, but fail to do so because of 'apparent' incommensurability, and limitations of current technologies and tools.

Central to this research is the hypothesis that patterns and pattern languages have the potential to address key epistemological, ontological and cybersemiotic[13] challenges, leading to the expansion of individual awareness and collective intelligence (Levy, 1997). This significant potential is unfulfilled as the complementarity of the versatile functions of patterns and properties of pattern languages as media for multidimensional sense-making, mediation and connectivity have not yet been fully and systematically investigated and operationalized into tools and methods for systemic intervention and transformation.

THE UNFULFILLED POTENTIAL OF PATTERNS

Patterns are everywhere. A Google search on the word *pattern* turns up more than a billion results! This is more than the word *economy* (700 million), similar to the word *shape*, slightly less than the word *thinking* (1.5 billion). From the work I undertook until now, a few characteristics emerge in theory and praxis, which point to cognitive, formal and processual functions of patterns. Patterns can be understood as dynamic multifaceted living systems, with many definitions and purposes.

For example, a pattern is at the same time:

- A unit of 'recognition' of form and inference
- A mental filter and interpretation framework
- A unit of representation of form
- An elementary unit of systemic fitness

[13] Linked to human and computer powered communication, information, intelligence, cognition, meaning and interpretation, in relation to human and computer communication. The cybersemiotic field was developed by Søren Brier (2008).

- A connective building block
- A structured and connected object – unit of knowledge
- A boundary object for hermeneutical inquiry
- A mediating and connective object for systemic intervention

My conviction is that these functions, if combined and operationalized into knowledge processing, mediating and sense-making tools and methods, would provide critical insights for dealing with complexity and diversity effectively and autopoietically. These functions are briefly outlined below.

Pattern as unit of 'recognition' of form and inference

One of the essential attributes of the human brain is its propensity and ability to recognize patterns to make meaning and trigger action. For social scientist Howard Margolis (1987), everything in thinking and judgment is reduced to pattern recognition. Margolis describes P-Cognition as a sequence or cycle where a pattern (whether static or dynamic) prompted by cues in a context, becomes itself part of the context, and cues another pattern. Conscious or not, this cycle is essentially a-logical and can happen in multiple cognitive dimensions at once, such as playing the piano while having a conversation. Habits of mind, developed through learning and practice, entail a more or less automatic prompting of patterns in perception as well as behavior. This has been illustrated by fighter pilot John Boyd (1995) in the OODA loop situational awareness model, which decomposes intervention in a cycle of Observation, Orientation, Decision and Action, performed at various paces and with various degrees of reflexivity/consciousness depending on how fast a situation can or needs to trigger a response (immediate sensory/affective or acquired reflex of the fighter pilot, or matured reflection in a strategic planning process).

We do not know how the brain works to accomplish this, and in situations of uncertainty we cannot predict or anticipate which patterns we will find in a given context. Margolis posits however that by observing responses in a given context we can reconstruct a pattern or sequence of patterns that would trigger these responses and from there anticipate and intervene on the related cues. Quantum physicist and mathematician Freeman Dyson (2014) identifies two big mysteries about how our brains work. The first is how our short term and long term memories are encoded. The second is how these memories are accessed and retrieved, and how chains of thought are formed. The logical structure of thought appears to be associative, with chains of thought connecting one memory with another, but there is no evidence on how and with which type of language these chains of thought are encoded and connected. A question that often arises is whether human brains are digital or analogue – a key question as far as developing artificial intelligence is concerned. Dyson opts for the analogue (i.e. non digital, non algorithmic and therefore non computable) functioning of the brain, which uses maps to process information and navigates from one map to the other. Even if language itself is digital in its processing of strings of phonemes and symbols as discrete objects, meant to help reconstitute meaning, strings of phonemes are not perceived as such. The meaning and images that language elicits by association mobilize affect and intuition as much as reason and judgment and proceed to the construction of an aesthetic. For architect Christopher Alexander who discovered and dedicated his lifelong research to pattern language, what is important in language is not the grammar and rules which help generate it, but the semantic networks which connect the word “fire” with “burn,” red,” and “passion” (Grabow, 1983). Similarly, what is important in pattern language is the ‘quality’[14] and processes, which can be generated through design (Alexander, 1979).

For Hofstadter and Sanders (2013), the human ability to make analogies lies at the root of all conceptualization and capacity to selectively evoke concepts, from the most basic in children language development to the most abstract leading to scientific discoveries. “*It is by logic that we prove, but by intuition that we discover*”: Henri Poincaré (1908) studied the role of intuition and analogy in physics and mathematics, exploring his own experience (he was as a productive mathematician). For Poincaré, analogical reasoning consists in finding hidden similarities and revealing deep identity of structure among what appears divergent in associations between seemingly disparate concepts or ideas brought about by intuition (Paty, 1994). One can argue that intuition is the manifestation of subconscious analogies or the discovery of new forms, which are then validated or formalized into new patterns in the mind. Pattern-to-cue-to-pattern sequences described by Margolis may work in a similar way as language, with the pattern as the discrete analogical sign, which can be ‘computed’ into sequences and performed as such once semantic associations are made. Once the analogy is formalized and ‘externalized’, i.e. made explicit, we get other types of patterns.

It follows that patterns are an essential element in the inference of meaning and for making sense of what is around us, whether through sensing, discovering or learning new patterns (induction), recognizing, guessing or adapting them (abduction), or using them to evaluate, reason and predict/plan (deduction). Figure 3 illustrates Charles S. Peirce’s Cycle of Pragmatism and the combination of modes of inference in a cognitive cycle (Sowa, 2015).

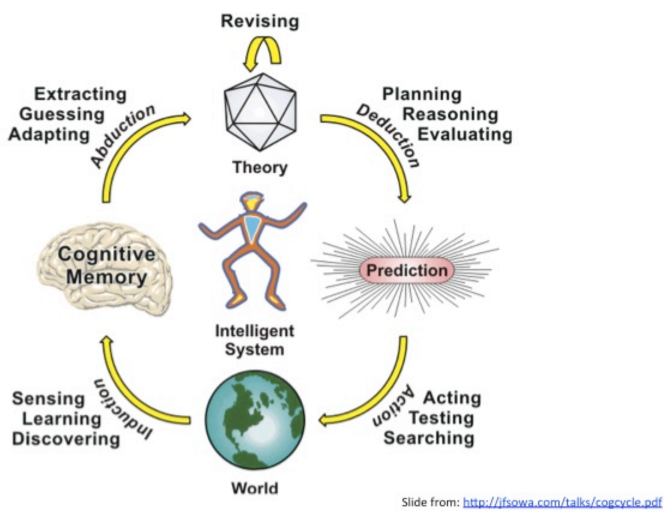

Figure 3. Peirce’s cycle of pragmatisme

These are all capacities and skills that need to be developed and systematized in technology and practice if we are to learn to better collectively detect the signals of change including imperceptibly weak signals and inflections in a noise of data, and to discover, interpret and act upon new patterns, differences and similarities among patterns to make sense of what emerges around us.

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14 The barely tangible life-enhancing quality has been defined in various ways: social activist Tom Atlee refers to it as Goodness,[14] physicist David Bohm as Wholeness,[14] cultural theorist Jean Gebser as Diaphaneity, Gregory Bateson as ‘The Pattern that Connects’. Alexander describes it as something desirable, ineffable yet readily perceivable with high levels of intersubjective agreement, calling it the ‘quality without a name’ (Alexander, 1979, pp 19, 26, 157)

Pattern as mental filter and interpretation framework

Patterns play a key role in how we process information and learn. French epistemologist Stiegler (2010) offers a functional description of the pattern-to-cue-to-pattern process and illustrates how it relates to the formation of worldview and culture, which determine decision and action frameworks as described above. When individuals learn or interact, what they perceive and remember from their lived experience creates imprints (patterns) at various levels in their individual and collective minds. Building on Husserl's phenomenological approach of temporal experience, Stiegler distinguishes three types of imprints he calls retentions.

Primary retentions are the most salient of our perceptions, i.e. the patterns we recognize or discover, that we select from moment to moment through the analogies we unconsciously make and that combine in the flow of our consciousness.

This flow enriches the memories of our experiences, i.e. our *secondary retentions*, that act as the mental filters or frame of reference, i.e the memorized sets of patterns or categories, which constitute our mental patterns or worldview against which we recognize new patterns, and through which we select our primary retentions and categorize what we perceive, in a feedback loop.

Tertiary retentions are the layers of conscious and unconscious sedimentations, the externalized tracks[15] of collective knowledge and memory accumulated through shared practice and experience and transmitted across generations. Alongside the co-evolution of our individual mental filters, these tracks play a key role at the social group / collective level in the processes formative of culture as well as collective agency[16]: a double feedback loop.

So the forms or patterns we discover or recognize as described above are actually conditioned by the sum total of what we have assimilated and processed before, different from one individual to another, yet co-evolving around social objects as described earlier in the paper. What we as individuals perceive is selected, categorized, interpreted and reconstructed in relation to what we know and how we understand. Understanding is the process of perceiving and categorizing[17]. What we know is what we have understood. Patterns are involved in both perceiving and categorizing, and therefore in understanding and the formation of knowledge.

Interpreting is how we make sense of what we are understanding or have understood, individually and collectively. We will see in later sections how formalized patterns can play a role in this process.

Patterns or signals that we cannot categorize and interpret because we cannot relate them to anything we know individually or collectively may be left out unseen, or perceived as threats. This 'natural' process of reduction is what hinders our capacity as individuals or groups to understand, recognize and relate to perspectives and logics that we are not familiar with.

As units of cognitive ergonomics, patterns can be operationalized into tools that can further assist (1) the discovery and recognition of form in a context, (2) the configuration

[15] This can be related to stigmergy.

[16] This last thesis on the individuation of social cognitive systems, which provides an interesting perspective on the structure-versus-agency debate, recently proposed in Lenartowicz, Weinbaum & Braathen (2016), is one I would like to explore further in connection to patterns.

[17] Jung's work on mental functions provide some insights on how we process information, which will be explored in relation to the topic in further research.

of form in the mind, (3) the extension/externalization (i.e. the representation) of form in context, and (4) the resulting expansion of consciousness.

One could imagine patterns and pattern languages helping to 'externalize' the way brains process patterns, as a technology to support collective awareness and intelligence.

Pattern as unit of representation of form

The patterns in our minds (secondary retentions), and those we see and capture from the world out there (primary retentions) co-evolve and determine the formalized artifacts we produce and the traces we leave (languages, art, and knowledge) in our environment (tertiary retentions). When thinking of patterns, visual/static forms often first come to mind. The basic definition of a pattern is that of a repeated form, found in nature or in the mind. Patterns may be captured, reproduced and evolved through human creation to produce specific generative, functional or esthetic qualities. Patterns are found in artistic forms, sounds and movement, in religious philosophical and mystical/shamanistic symbols, artifacts and rituals. They are found in the motives and shapes produced by design: carpet, tiles or carvings display instances of archetypal motives; templates or blueprints offer models for the reproduction of clothes, knits or embroideries as well as tools and machinery. Process patterns are found in recipes, in management, organization or production models, in software programming; in the recurrent configurations and formalisms of sciences such as mathematics (the 'pattern science par excellence') or biology (DNA, evolution); in the archetypes of psychology, and behavioral and social sciences. Archetypes, etymologically the 'original' pattern, model or type, are defined by psychiatrist Carl Jung (1964) as the unconscious representation of a universal prototype of a concept which may be used to interpret observations, externally manifested in symbols or tales and mythologies which can be found across cultures and time. They evolve as we focus our experiences. Systems thinking archetypes are types of patterns that encapsulate recurring systemic behaviors and situations. Patterns are not only the shapes, concepts and processes that we infer or conceive in our minds, but also the representations we create of these shapes, concepts and processes.

From a Peircean semiotic perspective a pattern is a sign. It is at the same time (1) an *object* or elementary system under focus (a phenomenological ontological 'form', static or dynamic, in its abstractness), (2) the *sign-vehicle* that represents, signifies or 'encodes' this object in relation to its context (a physical or explicit formal representation such as a symbol or artifact), and (3) the *interpretant* or understanding, interpretation, or 'decoding' of the connection between the object and its representation (the form it takes in the mind). This three-dimensional function (embodying the Peircean triadic sign as unit of inference) generates and evolves meaning from the recursive relationship between the three dimensions. A same ontological object may be represented by a variety of vehicles. Each interpretation of a signified object may generate a further signified instance (representation) of it, allowing a rich variety of combinations of networks of signs and meaning, enabling interconnections across, and navigation among, objects, representations and interpretations of different natures (Brier, 2008; Johansson, 2013).

In terms of cybernetic orders and systemic interventions, this opens the way to further develop pattern-based tools and approaches linking objects (first order), representations (second order), and interpretations and the shifts in mental retentions and behaviors they entail (third order), to empower and monitor orientation of complex systems (fourth order) towards thrivable futures.

Pattern as elementary unit of systemic 'fitness'

Architect Christopher Alexander, the first to formalize the concept of pattern language, argued that increasingly, complex urban planning problems could not be solved with complete sets of requirements, master plans or brilliant one-piece designs conceived by genius designers. Form needed to be adapted to the heterogeneous and conflicting forces of its context, which play out at different paces, levels and scales in unpredictable ways. Alexander (1979) was inspired by the process of design of vernacular cultures (and their 'timeless way of building'), grounded in tacit/implicit pattern recognition and knowledge, which enables in a piecemeal manner the adjustment of the rate, level and scale of adaptation to the needs or configuration of the context, and supports integration at multiple levels.

In his dissertation *Notes on the synthesis of form*, Alexander (1973) contrasts what he calls the 'unselfconscious' process of design in indigenous architecture where the user, the designer and the builder are closely associated, with the selfconscious process of contemporary design, where the designer is an external expert, working in isolation from user experience, and the resulting form disconnected from its context, thus compromising its assimilation or fitness, and its ability to generate emergent qualities or functions. The first concept of patterns Alexander introduces is the diagram. He describes a diagram as "*an abstract pattern of physical relationships, which resolves a small system of interacting and conflicting forces*[18]". Following the tracks of Herbert Simon (1962), Alexander observes that complex systems can be partly decomposed into independent subsystems bound by strong internal forces, themselves inter-acting through weaker links to produce effects aggregated at other levels. Such subsystems, identifiable and recognizable by the human mind, can be treated as independent units of design, recombinable into new models or forms, following grammar-like rules. Unlike one-piece designs, models made of combined patterns created and improved one at a time can be probed and adapted in a purpose-seeking rather than goal-directed manner, thus enabling exploration and learning. Complex adaptive wholes evolve 'piecemeal' in the process without predefining specific structures in advance.

The 'grammatisation'[19] of the modeling process provides a method for sense-making which enables inquiry for each pattern considered, and at each connection. Each connection is a hypothesis in the purpose-seeking process, which adapts through a number of intermediate stages.

The resulting models are context-adaptive, allowing multiple points of contact between the new form and its context, and the formation of networks of adaptations, enabling a greater degree of 'fitness' of the designed configurations to the multiple 'asperities' of the 'reality' of the context, and the factors that may affect it. Setting boundaries at various levels allows multiple combinations and levels or scales of experimentation and analysis.

Time is as important as space. Simon (1962) makes a distinction between state descriptions (which characterize the world as it is perceived at a particular given time) and process descriptions (which specify the means of producing objects that have certain sets of characteristics over time). He describes the task of an adaptive organism in search of transformation as identifying the differences between an existing state and a desired state and finding the processes that can 'erase the difference'. He suggests that the constant translation between state and process related to the same defined aspect of reality is key to problem solving which seeks to define and refine sequences of processes that will produce goal states.

[18] Quote from the preface to the paperback edition of the *Notes.*
[19] The breaking down into discrete elements

We can think of the notion of configuration here, understood as an arrangement of form aimed at generating a specific outcome or quality, also known as gestalt. In a purpose-seeking problem-solving process, a pattern can be seen as a configuration producing intended processes, themselves generative of required qualities. Sustainability, thrivability or 'aliveness' (Leitner, 2015) can be pursued as quality. State descriptions, then, rather than capturing situations of equilibrium, can be seen as snapshots in a continuum of interacting processes, which enable the monitoring of a system's orientation and an adjustment of course if needed. The 'difference', or net 'added value' generated as output of a process, becomes an input itself, the seed for something new or for the regeneration of the system, working in an autopoietic manner. In this context, patterns are open-ended, and 'never finished' because the system is constantly in a 'becoming' state, seeking to generate processes able to 'fix' themselves on an ongoing basis.

The difference between a complex adaptive model and a traditional model is that the final goal or quality is neither prescribed (purposive model) nor pre-determined (purposeful model), but set as an ideal with adaptable intermediary goals (purpose-seeking model). A purpose-seeking model, just like a purpose-seeking system, seeks to converge towards an ideal future state, and upon attainment of any of its intermediate goals then seeks another goal, which more closely approximates its ideal (Jones, 2014). This implies monitoring intermediary states as generative configurations, and maintaining them so that they can continuously generate intended sustainable outcomes. It also means putting ideal future states or intended sustainable outcomes into question over time, as part of a pharmacological inquiry.

In practical terms, purpose-seeking/context-adaptive modeling supported by pattern language as agile technology (Cunningham & Mehaffy, 2013) would consist in decoding (i.e. interpreting and/or articulating) and encoding (modeling and prototyping) problem situations and responses with and into patterns, in order to track changes in configurations, processes and behaviors of pattern encoded objects, and adjust orientation in relation to intent (Finidori et al., 2015).

Pattern as connective building block

The pattern thus has the potential to become an essential building block for encoding and decoding systemic orientation, step-by-step in space and/or time in ways which seek to uncover the implicit, tacit or hidden.

Complexity economist Brian Arthur (2015) refers to complexity as looking at elements interacting in the system, asking how patterns are formed and how they unfold. For Arthur, it is more about discovering configurations and generative processes, and the patterns they produce, than framing 'the' problem and finding 'the' solution.

Identifying patterns includes learning to take things apart and probe connections in order to understand the relationships between components and make scenarios, to ultimately curate and act upon systems in informed ways. This is the essence of a hacker's approach such as described by Scott (2014, 2015) in relation to the finance system: "*The large part of the complexity and opacity we are faced with is that it neutralizes political action. There is ... a large diffuse body of people who can't really articulate what they don't like about the [financial] system and how to change it… I used the hacker ethics analogy and framework… It involves exploring something to see it not as a thing, but as a set of interacting components. Hacking is figuring out the internal impulse of things to figure them out. But the important question with the hacker approach is what are you aiming to achieve with this impulse*." In a similar approach, identifying systemic patterns that capture perceived configurations, processes, behaviors in a system would help compare perceptions, representations and interpretations across contexts and domains, and collectively assess, in a pharmacological approach, how sustainable or how functional or dysfunctional the system is.

Operationalizing this further would involve the identification and use of systemic interpretation patterns: patterns to render generic systemic configurations, processes and behaviors across domains, and mediate among representations and interpretations. A systemic modeling language?

We think of Poincaré seeking deep identity of structure among seemingly disparate concepts to trigger new thinking (Paty, 1994), and of Bertalanffy's (1968) idea of a shared systemic language across disciplines and domains based on *systemic isomorphies*, to unite sciences while preserving specialized knowledge. Without calling for the unity of sciences, and universality of this language, we can consider systemic interpretation patterns as formalized representations of these identities of structure or isomorphies, i.e. as 'patterns that connect' different instances/representations of systemic isomorphies across domains of focus, enabling new forms of learning and creativity through exploration and cross-pollination.

Pattern languages have the capacity to evolve in order to support such approaches and better combine and leverage the various functions and properties of patterns, in particular, finding 'patterns that connect' the phenomenological, psycho-cognitive, socio-social, and systemic dimensions of complexity. This would involve a conceptual operationalization of patterns: comparing the use of the concept of patterns and their representations in several relevant transdisciplinary domains (including: information science, semiotics, cybernetics, cybersemiotics, complexity science, general systems theory, social systems, cognitive sciences and computer science), and finding invariants, as well as interconnections among them.

As a step in this direction, Finidori et al (2015) introduced the concept of a new generation of pattern languages oriented towards the collective interpretation of dynamic systemic forms, bringing systems sciences, systems thinking, and design in closer cooperation. The purpose of this new generation of pattern languages is to connect, in a critical/appreciative hermeneutical approach, different types of agencies and intentions across domains of practice in order that the search for systemic functionality and quality using generative patterns converges on optimal solutions, without necessarily seeking consensus or the use of overarching/ meta-paradigms or methodologies. These pattern languages, built upon insights from previous pattern and pattern language research, can be constructed as generative frameworks bringing various cybernetic orders (seen as 'moments of inquiry') in recursive intraction at various levels and scales with the systems they are meant to model or design. This will be developed in a later section.

Such systemic interpretation patterns would serve to index or mark-up, across cybernetic orders, the configurations, perspectives and processes observed during interventions, recorded in social network conversations, or captured in knowledge databases, in view of their evaluation, comparison or interconnection across domains of application. They would also be used in interventions combining experimental design and post-hoc data analysis for the reconstruction of phenomena and multidimensional dynamics (Chavalarias et al., 2009).

Taking the analogy of the hacker approach further, one can imagine such patterns and pattern languages being used to reverse engineer hidden phenomena and processes, including 'black box' algorithms, which directly influence socio-technological processes, and produce indirect/emergent effects on socio-ecological systems.

Sequences of patterns as generative processes could eventually be recorded and 'played' or performed as algorithms, embedded in digital learning networks and tools that would enhance human cognitive ergonomics and extend human abilities to identify, recognize, represent and interpret phenomena, situations or systems, and navigate across interconnected bodies of knowledge.

Pattern as structured and connected object / unit of knowledge

State of the art pattern languages provide ways to capture tacit user as well as expert experience and best practices in a systematized way, and document them so they can be accessible to others. In *A Pattern Language*, Alexander (1977, p X) writes "*Each pattern describes a problem which occurs over and over again in our environment, and then describes the core of the solution to that problem, in such a way that you can use this solution a million times over, without ever doing it the same way twice.*" Making patterns reusable *a million times* involves generic description formats, which can help capture the 'gestalt' of a solution[20], so that they can be generalized and be made inter-operable among similar uses.

In practical terms, Alexander defines a pattern as a three-part construct[21]. First comes the 'context', the conditions under which the pattern holds. Next is a 'system of forces', also described as the 'problem' or 'goal'. The third part is the 'solution': a configuration that balances the system of forces or solves the problem presented. This formalization of patterns and pattern languages, setting the premises of an open standard, led to the adoption of patterns languages as medium for design in many areas other than architecture, in particular in software engineering. Pattern languages are also in use in many different areas of sustainability, including bioregional development[22], community action on climate change[23], and the Transition movement of community-based sustainability initiatives (Hopkins, 2011). Even if patterns come in many different design formats, some form of standard exists: most patterns comprise an illustration, and sections on context, problem /forces, solution, consequences and connected patterns as components.

Wikis were actually initially developed by Ward Cunningham to support pattern languages for software programing, enabling the collaboration, documentation and interconnection of patterns via hyperlinks. The formal digitalization of the pattern in wiki format enabled software patterns to be created and evolved by large communities. A whole practice of pattern writing developed in the past decades, which prefigures possibilities for further interoperability if interconnection among patterns of different disciplines and domains was to be pursued, and frameworks, open standards and protocols were developed to enable it.

In contrast, Alexander's initial set of 253 patterns in *A Pattern Language* remained confidential and 'frozen' because confined in the pages of a book, and later, in a copyrighted website that prevented add-ons and falsification, which would have enabled the initial set to be shared and improved by broader communities of users (Cunningham & Mehaffy, 2013).

Cunningham and Mehaffy (2013 p.6) claim that wikis are a form of elementary pattern language. They list the following characteristics that wikis and patterns have in common:

> *A. Both are open-ended sets of information, consisting of unitary subsets (pages*

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20 i.e. the systemic intention and elements that underpins it - http://www.europlop.net/content/introduction
21 hillside.net/patterns/about-patterns. [Retrieved April 5th 2015]
22 http://www.reliableprosperity.net/ [Accessed April 5th 2015)
23 http://www.communitypathways.org.uk/ [Accessed April 5th 2015)

or patterns) connected by hyperlinks. Each set of information is able to expand, while remaining within a linked network.
B. Both are topical essays with a characteristic structure: overview (with links), definition, discussion, evidence, conclusion, further links. This limited structure creates the capacity for extensibility and interoperability – the capacity of new pages to function smoothly with older ones, with the capacity for open-ended growth.
C. Both are structured to be easily creatable, shareable and editable by many people. This capacity facilitates the creation of user communities, who are crucial to the development of a large and useful body of shareable pages or patterns.
D. Both are (in principle) evolutionary, falsifiable and refinable. As structured essays, both make assertions about characteristics of the world they describe – assertions that can be falsified. Once falsified, they can be modified to correct discrepancies, and to refine accuracy. This evolutionary capacity translates into greater accuracy and usefulness over time.
E. Both aim to create useful ontological models of a portion of the world, as a more formalized subset of language. These are models of design specifically for pattern languages, and models of knowledge more generally for wikis.

We could add to this list the 'compactness' of form and the distributed nature of the pattern as versatile knowledge object, and the possibility for its standardization, which would allow the embedding of patterns into other digital or non digital tools and methods beyond the traditional repository, to further support the functions of the pattern described in the sections above.

The pattern as vehicle for representation in the Peircean triadic sign described above, is itself a 'rich' connected object with a generic template-like form whose content can be organized in systematic ways and evolved collaboratively through repeated application and evaluation.

Technologies and models of open source software could be used to support the 'agile' creation and collective maintenance of patterns as open standard and the operationalization of the pattern in analogue/cognitive tools and methods to be combined in field interventions, in order to broaden the use of patterns across domains and disciplines. With the development of the semantic web, semantic connectors between patterns other than hyperlinks can be envisaged, opening up possibilities for crossing domain specific boundaries and exploring interconnected bodies of knowledge.

A further formal operationalization and systematization of patterns and pattern languages would require the digitalization of an extended concept of pattern as object for, among others, the processing and navigation of patterns and pattern languages, data base indexing, scenario building and simulation supported by technologies such as text analysis, big data clustering, machine learning, reverse algorithm engineering, etc.

With regard to sustainability examples, this can add greatly to the repertoire of digital resources that can be used to support, enhance and explore analogue relationships more fully. So far the main digitally supported activity has been the modeling of systems that provides opportunities for scenario runs with different input data as used in climate modeling in the most well known case. Systems modeling can be linked to participatory systems dynamic diagramming with groups of stakeholders, producing robust digital decision-support tools capable of processing a wide range of information variables chosen by stakeholders (Koca & al. 2013). The potential range of digital resources covers those that can data-mine for patterns across related fields of inquiry, but also a range of digital tools could be designed to support different phases of cross-boundary and interdisciplinary work for sustainability.

Patterns as boundary object for hermeneutical inquiry

With their ubiquitous forms, versatile functions and formal structures that can be standardized and digitalized, patterns make ideal boundary objects. Boundary objects, term first coined by sociologist Susan Leigh Star are "*objects which are both plastic enough to adapt to local needs and constraints of the several parties employing them, yet robust enough to maintain a common identity across sites. They are weakly structured in common use, and become strongly structured in individual-site use. They may be abstract or concrete. They have different meanings in different social worlds but their structure is common enough to more than one world to make them recognizable, a means of translation. The creation and management of boundary objects is key in developing and maintaining coherence across intersecting social worlds*." (Star & Griesemer, 1989, p393)

Boundary objects have a key role in meaning-making and in mediating communication across groups. They act as attractors around which opinions can be clustered and mapped, boundaries probed, controversies identified, and points of vue and interpretations confronted and meta-stabilized. What lies 'in between' can be explored as boundary objects as well, enabling navigation across complexity factors and dimensions.

A wiki-like open standard format lends itself for patterns to be 'created and managed' (i.e. evolved) as boundary objects subject to on-going hermeneutical inquiry.

Wikis are increasingly used as community knowledge repositories because they allow users to quickly and easily share, modify and improve information collaboratively using templates (Leuf & Cunningham, 2001). Wikipedia is the state-of-the-art example of successful application of wiki to the aggregation and interconnection of knowledge. With the help of its editors, the wiki has evolved into a structure able to produce a working reliability of information (Wikimedia Foundation, 2011). Its processes turn it into "*a 'federated" body of knowledge (along with the tool to share it) [which] can function as a kind of "chorus" – a larger network of voices that are not stating exactly the same thing, but that contribute, through their very diversity, to a larger whole. From that larger whole, a working consensus can emerge*" (Cunningham & Mehaffy, 2013, p10). Wikipedia's working consensus allows a meta-stabilization of the knowledge for a substantial portion of what is produced, and the flagging and documenting of content weakly supported, or subject to significant controversy.

Contrary to Wikipedia however, which seeks synthesis and consensus, a hermeneutical approach as intended here would accommodate the uncertainties of complex challenges and allow the coexistence of diverging interpretations and controversies (which systems such as Github[24] support), attempting to find bridges among them (for one thing avoiding edit wars). The pattern itself would never be 'final'. A 'living learning object'.

The discussions and controversies would not only be tracked and documented (as with a wiki edits and discussion page, or Github type of versioning) but they could be also be categorized and semantically marked up, to build an understanding of the processes of innovation and transformation. Tools and methods could help to document pattern formulation, evaluation and evolution and the systemic interventions based on them, as well as the outcomes of the interventions, subjecting these to the same hermeneutical processes.

[24] A Github type of standard would be a natural evolution for pattern formalization. Github is a repository for software code with distributed revision control such as wiki, and more collaboration features, including for production. The forking feature allows several versions to coexist, with options to merge and meta-stabilize versions.

The related forms developed would actualize the claim that, *"[P]attern languages could become effective research tools in their own right, hastening the development and application of useful scientific knowledge at a time that the world needs it more than ever," providing, "a way of managing the explosion of information on the web, and in our lives – and more importantly, a way of assessing the reliability and importance of information and knowledge, in a way that seems most likely to enrich our lives, and our civilization*." (Cunningham & Mehaffy, 2013, p16)

Through interacting around patterns as boundary objects, using tools allowing scenario building and different impersonations, as well as navigation among adjacent possibles, communities of practice involved in multistakeholder interventions would evolve both the understanding of their own knowledge and know-how, and discover more of the unknown. This would actually enact the process of joint discovery illustrated in the Johari Window model below, and provide rich learning material to feed back into interventions.

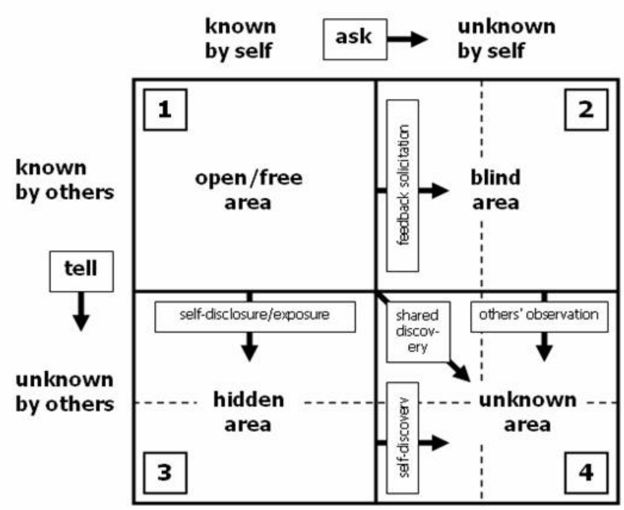

Figure 4. The Johari Window[25] opens up on self-awareness and shared discovery of the unknown, to expand the boundaries of our perception.

Such tools and methods would support the interconnection of various dimensions of systemic interventions across levels, scales and temporality, through whole sets of semantic links and 'patterns that connect', enabling pathways for inter- and transdisciplinary exchanges, joint-exploration and navigation to foster cross-fertilization, synergy and learning, bringing to life the 'adjacent possible' proposed by Stuart Kauffman:

"*The strange and beautiful truth about the adjacent possible is that its boundaries grow as you explore them. Each new combination opens up the possibility of other new combinations. Think of it as a house that magically expands with each door you open. You begin in a room with four doors, each leading to a new room that you haven't visited yet. Once you open one of those doors and stroll into that room, three new doors appear, each leading to a brand-new room that you couldn't have reached from your original starting point. Keep opening new doors and eventually you'll have built a palace*." (Johnson, 2010)

Applied to sustainable futures and thrivability, hermeneutical approaches using patterns

25 <http://bit.ly/1K8dMt1>. [Accessed April 5th 2015]. Image © Alan Chapman 2003 [http://www.businessballs.com].

as boundary objects and the tools and methods supporting them would provide change agents with the capacity to:

- Interpret, discuss and articulate sustainability challenges and capture and design sustainable practices in systemic and dynamic terms,
- Appreciate and reflect upon multiple interpretations and pathways and support co-created solutions, while ensuring systemic coherence and systematically organizing and leveraging knowledge.
- Evaluate the 'systemic' sustainability of practices and perceived dynamics from philosophical, ethical and pharmacological perspectives
- Support the documentation and reprocessing of inquiry, discussions and field experience in order to keep the data alive and grow the commons of sustainability knowledge as the 'memory' of collective intelligence in action.

Pattern- and pattern language-based networks of knowledge would act as scaffolds that accommodate and aggregate different kinds of locally focused actions, narratives and powers towards shared ideals, manifested differently in different localities, supporting ecosystems of change (Pendleton-Jullian, 2012)characterized by a diversity of identities and possible pathways towards sustainable futures. The aim is to foster an optimal leveraging of collective intelligence and agency, and in particular of its diversity and distributed nature, in an integrative and contextualized way.

Pattern as mediating, connective object for systemic intervention

The paper so far has highlighted the variety and multidimensionality of the factors affecting complex systems, and the need to connect and collectively navigate among these different dimensions. It has also outlined the different forms/functions and uses of patterns and provided some directions on how they could be further operationalized.

Patterns and pattern languages are already in use in many domains focusing on these dimensions taken individually, but not really in synergetic integrated ways, where the 'qualities' and functions, perspectives and moments enabled by patterns can be leveraged as a system, with outcomes greater than the sums of what is achieved in each domain.

From a pragmatic, perception-to-action cycle perspective:

Patterns are involved at different temporal levels. We saw above how the cognitive functions of patterns could be combined in Sowa's (2015) cognitive cycle inspired from Charles S. Peirce, and in Boyd's observation-to-action (OODA) loop. The cycle could be extended to more formal and processual functions in order to support systemic interventions and constellations of shared knowledge.

The extended perception-to-action cycle below, which can be correlated to a maturity cycle of the pattern, is composed of 'moments'[26] or phases to which a variety of processes involving patterns can be connected. These processes are more or less conscious and explicit, more or less fast paced, more or less 'synchronous', more or less consensual, and more or less assisted by models, tools (digital and analogue) and methods:

(1) observation / perception
(2) recognition / identification
(3) interpretation / discussion
(4) capture / categorization / design

[26] I am borrowing here the notion of 'moments' from Gerald Midgley (2000), which I apply in the context of the cognition cycle, a connection Gerald Midgley did not directly make. I will be exploring this notion of moments further in my research.

(5) storage / interconnection
(6) exploration / orientation
(7) option processing / decision / planning
(8) implementation / deployment
(9) evaluation / assessment / maintenance

The cycle involves multiple cognitive systems, processes and technologies/formalisms interacting with each other and with their environment at various paces, levels, and scales (individual, cohesive group, societal, etc.). System behavior is shaped by a myriad of interconnected and nested cycles of this type that unfold with various degrees of synchronicity, interacting with natural phenomena to produce emergent effects that influence the orientation of socio-cognitive-technological-ecological systems.

Each phase of the cycle has its specificities and complexities. Each phase can be supported by pattern-enabled tools and methods, leveraging different features and combinations of pattern functions, and producing outputs that can serve as inputs for other phases.

From a 'spatial/position', cybernetic orders perspective:

Patterns are also involved at different spatial levels, encompassing phenomenological, psycho-cognitive, socio-cognitive, and complexity dimensions. The four cybernetic orders I described above provide an interesting way to bring these dimensions into focus and navigate among them in intervention contexts, in conjunction with the temporal ones.

Within specific domains of focus seen from a first order cybernetic perspective (an 'objective' view within a cohesive domain), a pattern language as combination of patterns defined as system of strong inter-related forces can help investigate and capture interacting components of situations, phenomena and systems, and formalize both explicit and tacit knowledge in a given domain. This is state-of-the-art scientific, expert or vernacular formal knowledge, based on the 'reality' that communities of practice or cohesive/homogeneous socio-cognitive systems as described above may consider objective and valid in a domain. Used and applied 'locally', it enables maximization of fitness to local terrain in goal-directed and effectiveness-seeking strategies. What is needed to complement current domain-specific pattern languages is (1) a more robust systemic inquiry into the configurations, generative processes and potential outputs and outcomes of the systems intervened upon to enable purpose-seeking pharmacological approaches in addition to goal-directed ones, and (2) a capacity for connectivity across dimensions for knowledge exchange among domains and approaches.

Taking a second order perspective, an object may be seen differently by different observers. The different representations and interpretations generated for the same object, associated forces at play and resulting functionality/quality (first order), can be revealed to each other through hermeneutical approaches using the pattern as boundary object. The study of differences and similarities undertaken in action research or participatory contexts may uncover new types of patterns, which can help stakeholders understand how their own cognitive and cultural patterns may be formed and evolve, and how these patterns may influence the way each individual or group looks at and represents an object in focus, and acts upon it, helping to ultimately highlight incommensurability and complementarity in approaches, and manage tensions between similarities and differences. Such learning is key to both domain specific action and transdisciplinary interventions. It involves reflection in action and on action, involving double loop learning (Argyris, 1982).

Being exposed to and consciously reflecting upon new patterns both in action and on action can change an individual's mental retentions and therefore worldview and resulting actions. Tools and methods combining functions of the pattern can themselves be associated in interventions to foster this exposure and these reflective processes. Connective patterns and associated realizations entail possibilities for broader collective views of an observed object, and recursive interactions between the various elements at play. Taking a third order perspective may help identify new worldviews and evolutions of patterns of behavior in a system (first and second orders), in particular in relation to the impacts of human action, communication and structures. Especially it may help reveal stigmergetic and aggregation processes, and power structures. These insights which can be acquired through the decoding/reconstruction of multidimensional dynamics are necessary to conduct epistemological, ethical or pharmacological inquiries and to identify margins of manoeuver with respect to agency.

With a fourth order perspective, the inquiry can focus on the relationships within and among other order systems, draw boundaries at successive levels, explore intersections between systems and factors of different nature, and seek patterns that connect at broader levels. The observer is a network of empowered agents which probes fitness at each node or local context, proceeding with successive approximation to desired and iteratively formulated qualities that are understood as emergent, making the patterns and processes that support iterative inquiry visible and accessible, while maintaining the cohesiveness of the whole (Finidori et al., 2015). This is a step towards the curation and collective orientation of emergent properties in the system, facilitating at the same time the formalization, monitoring and iteration of desired generative functions and qualities in the system in an adaptive manner.

All these activities can be conducted collaboratively in participatory interventions covering both spatial and temporal dimensions of complexity. Iba (2014) illustrates how patterns and pattern languages can be used for experience mining, experience analyses, and experience visualization, providing a rich medium for collaborative sense-making and co-creation. Such pattern processing frameworks could be used to reveal or connect dimensions of complexity in participatory settings.

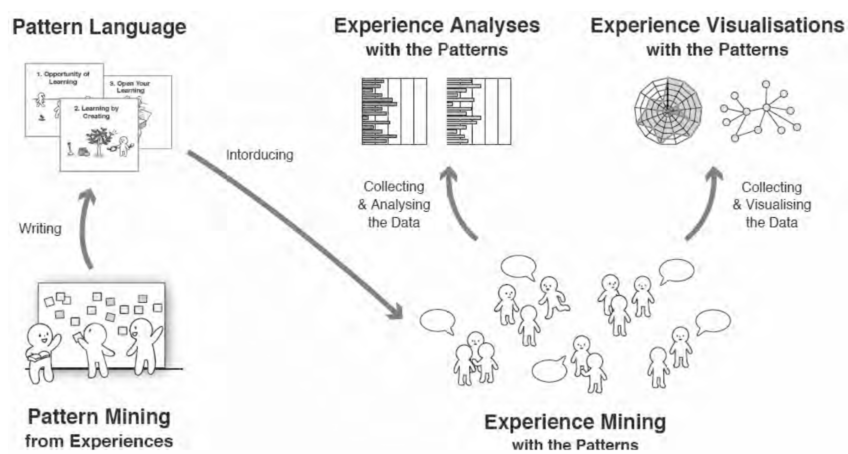

Figure 5. The overview of experience mining, experience analyses, and experience visualization with patterns (Iba 2014).

CONCLUSION

Many theories, models, tools and methods from a variety of disciplines inform or address specific phases of the perception-to-action cycle and elements covered under individual cybernetic orders, leveraging patterns in dispersed ways in the areas of the sciences (evidence and identified concepts), the 'arts' (applied technique/skills and creative expression), and cognition (imagination, interpretation and learning).

Few theories, tools and methods or frameworks however connect these processes and approaches in their inter-related unfoldings to tackle complex systemic challenges in their multiple dimensions. Alexander's design patterns (1977, 1979) are not related to Margolis' recognition patterns (1987), and neither relate to Bateson's 'patterns that connect' (1979). Fewer seek to uncover isomorphies (Bertalanffy 1968) in systems structures and dynamics observed across disciplines and domains.

An operationalization and systematization of the multiple functions of the "pattern that connects" and heir embedment into sense-making, configuring and mediating tools and methods would provide interfaces between the various spatial and temporal dimensions of complexity, enabling the emergence of networks of adaptations better 'fitted' to the distributed, fragmented, emergent nature of complex systemic challenges.

Pattern based tools and methods combined in systemic interventions would provide major breakthroughs in addressing the issues of knowledge fragmentation and unity in diversity, and enabling the collective curation of emergent thrivability and the realization of sustainable futures.

Elaboration on the topics outlined in this paper will be subject to further research in the course of an upcoming PhD program, and other collaborative research endeavors I will be engaging in.

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