Wicked problems, systems approach, pattern language, ecological epistemology, hierarchy theory, interactive value:
Multiparadigm inquiry generating service systems thinking

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Abstract:

Systemic design methods in the 21st century have roots in systems theory developed in the 20th century, centering around prominent figures. Within the ecology of systems sciences, six schools of thought coevolved across a variety of domains.

- *(i) Wicked problems and Issues-Based Information Systems were the focus of Horst Rittel, continuing as argumentation schemes.*
- *(ii) The systems approach with inquiring systems from C. West Churchman fed the interactive planning of Russell Ackoff.*
- *(iii) Pattern language originated in the built environment by Christopher Alexander, was cross-appropriated into information systems by members of the Hillside Group.*
- *(iv) Ecological epistemology in anthropology started by Gregory Bateson has been extended and refined by Tim Ingold.*
- *(v) Hierarchy theory in ecological systems by Timothy F.H. Allen is a foundation for the panarchy and resilience science of C.S. Holling and Lance Gunderson.*
- *(vi) Interactive value and theory of the offering from Richard Normann led to business orchestration by Rafael Ramirez and Johan Wallin.*

During this period, the design profession has evolved with changes in technology. Building things and places centered on structuralism. Constructing experiences draws on phenomenology. The rise of information technology has resulted in a turn towards interaction and materiality.

Service systems thinking proposes a generative pattern language structured on (i) voices on issues (who + what), (ii) affording value(s) (how + why), and (iii) spatio-temporal frames (where + when). This approach comes through multiparadigm inquiry that builds on the history of systems theories developed from the 1960s into the 1990s. Paradigm interplay leads to a philosophical turn for systemic design in the context of the 21st century.

Keywords: *wicked problems; systems approach; pattern language; ecological epistemology; hierarchy theory; interactive value*

0. Introduction

Generative pattern language, in its history, was originally intended for the domain of "town, buildings, construction" (Alexander, Ishikawa, & Silverstein, 1977). In an early specification for multi-service centers, the prototype design ...

> ... deals chiefly with the spatial organization; but since human and spatial organization cannot properly be separated, many of the specifications given in this report go into questions of human organization as well. [….]
>
> The ultimate purpose of a prototype design, then, is to provide guidelines which will generate a large number of specific buildings (Alexander, Ishikawa, & Silverstein, 1968, p. 1).

The original charter for the Center for Environment Structure was clear in its emphasis on the built environment.

> The pattern format is designed to express ideas about the physical environment in a clear way. In doing so, it opens these ideas up to exacting criticism and improvement (Alexander, Ishikawa, & Silverstein, 1967, p. 1).

The PURPLSOC community acknowledges "invariant spatial patterns associated with the stability of human-environmental systems in both towns and buildings", with the pattern approach …

> … beyond architecture and urban design and ... in many other disparate fields, such as design, media, arts, IT, management, pedagogy, social activism, social innovation and diverse grassroots movements. [….]
>
> The PURPLSOC (In Pursuit of Pattern Languages for Societal Change) platform aims to substantiate the broad applicability and richness of pattern related work in all fields, and by sharing best practice examples from outside the scientific community to further raise awareness of this approach to encompass the wider public. Additionally PURPLSOC offers a platform to discuss and study Alexander's most recent research work …. (Baumgartner & Sickinger, 2014, p. 3)

More generally, pattern language can be seen as an approach to ill-structured problems. In the domain emphasizing *organizational* ill-structured problems – "problems which involve more than one person in their formulation, solution, implementation and evaluation":

> … an ideal of "pure type" ill-structured problem is defined as one which possesses one or more of the following characteristics (Rittel, 1971): (a) The problem is well-defined in the sense that it can be clearly stated but those charged with dealing with it cannot agree upon an appropriate solution or strategy; (b) they cannot agree on a methodology for developing such a strategy; or (c) they cannot even agree on a clear formulation (definition) of the problem (objectives, controllable variables and uncontrollable variables). Simply stated, ill-structured problems are who Ackoff (Ackoff, 1974) has termed "messes": they are complex mixtures of highly interdependent important problems that by definition cannot be formulated, let alone solve, independently of one another (Ian I. Mitroff & Emshoff, 1979, p. 1).

With pattern language, the work of Christopher Alexander is one approach towards dealing with ill-structured problems. Alternative approaches are not only in practice today, but were also in active development by the late 1960s.

Appreciating the variety of approaches may involve crossing paradigms. Giving due diligence, three questions are addressed in the text that follows.

1. What is multiparadigm inquiry?
2. Where have (and might have) (1960s-2010s) paradigms influenced generative pattern language?
3. Why might a pattern language project or community pay more attention to its paradigm?

This exposition serves as a prequel to a “Pattern Manual for Service Systems Thinking” (Ing, 2016), in the same way that the “Pattern Manual” (Alexander et al., 1967) was a beginning for the work in built physical environments.

1. What is multiparadigm inquiry?

“Inquiry is an activity which produces knowledge” (Churchman, 1971, p. 5). While a library can be a “collection of information”, a pragmatic action conception of knowledge sees that “knowledge resides in the user and not in the collection” (Churchman, 1971, p. 10).

Modern science is a creator of knowledge. A critical view of science surfaces some limits.

> There will be the suggestion that science’s mode of representing nature is very restricted, so that it cannot even talk about some of its most pressing problems and specifically its relationship to other social systems. For example, science has no adequate way of studying its own relationship to politics, to religion, or even to a system apparently quite close to its own interests, education. As a system, science cannot discuss social change (implementation) in any but a very restricted sense (Churchman, 1971, p. 18).

These issues with science lead us to philosophy. The philosophy of science studies what qualifies as science, the reliability of science, and the ultimate purpose of science. *The Structure of Scientific Revolutions* (Kuhn, 1967) is a well known and often cited work by graduate students across a broad spectrum of disciplines.

1.1 The structure of scientific revolutions is built on paradigms and shifts

The Oxford English Dictionary provides 4 major definitions of science, of which our interest falls primarily on the fourth.

> 1. A pattern or model, an exemplar; (also) a typical instance of something, an example.
>
> 2.
>
> a. *Grammar*. In the traditional grammar of Latin, Greek, and other inflected languages: a pattern or table showing all the inflected forms of a particular verb, noun, or adjective, serving as a model for other words of the same conjugation or declension. Also *fig*.
>
> b. Linguistics. A set of units which are linguistically substitutable in a given context, esp. a syntactic one.

3. Rhetoric. A figure of speech in which a comparison is made by resemblance; = *paradigma* n. 1. rare.

4. A conceptual or methodological model underlying the theories and practices of a science or discipline at a particular time; (hence) a generally accepted world view.

1962 T. S. Kuhn Struct. Sci. Revol. ii. 10 'Normal science' means research firmly based upon one or more past scientific achievements..that some particular scientific community acknowledges..as supplying the foundation for its further practice... I..refer to [these achievements] as 'paradigms'.

Thomas Kuhn saw normal science under a paradigm, with revolutionary transitions to the next paradigm. This is depicted in Figure 1.

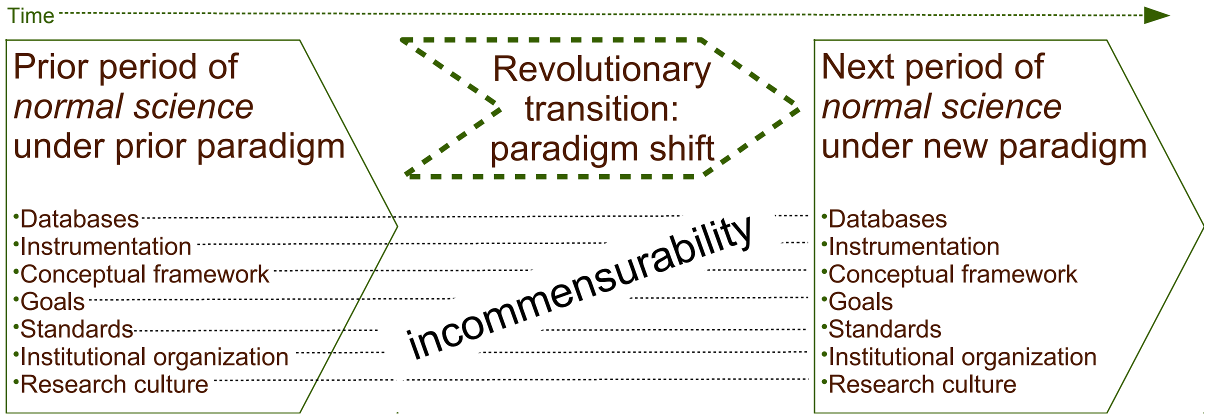

Figure 1: Normal science, scientific revolution, new paradigm

> Kuhn modeled the history of a science as a succession of dogmatic periods of "normal science" under a "paradigm", separated by "revolutionary" transitions to the next paradigm. According to Kuhn such a break from the past rejuvenates a field that had stagnated under the weight of anomalies that it no longer seemed to have the resources to solve. A new paradigm introduces changes at all levels, from established databases and instrumentation to the conceptual framework, goals, standards, institutional organization, and research culture—so much so that some older practitioners can hardly recognize the new paradigm as their field. This disconnect produces "incommensurability" across paradigm change, ranging from communication failure to problems of rational choice between the two, since there exists no fixed measure of success (Nickles, 2017).

If a fine distinction were to be made, a worldview is based on values and beliefs, whereas a paradigm relates to constructs that scientists count as knowledge. Individual human beings each have a world view. Groups of scientists can share a paradigm.

1.2 Multiple paradigms can be recognized in concurrent plurality

In the social sciences, theories of organization can be conceptualized with sets of assumptions related to ontology, epistemology, human nature and methodology. Mapping along the dimensions of (i) the nature of science as subjective or as objective, and (ii) the nature of society in terms of regulation or radical change, four paradigms are described: (a) a functionalist paradigm (with objective regulation); (b) an interpretive paradigm (with subjective regulation); (c) a radical humanist paradigm (with subjective radical change); and

(d) a radical structuralist paradigm (with objective radical change), drawn in Figure 2. These define "very basic meta-theoretical assumptions which underwrite frame of reference, mode of theorising and modus operandi" of the theorists who operate within them (Burrell & Morgan, 1979, p. 23).

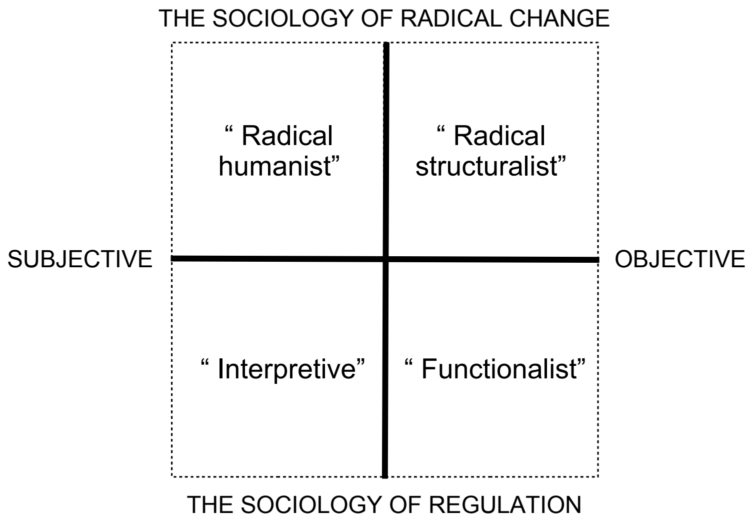

Figure 2: Four paradigms for the analysis of social theory (Burrell & Morgan, 1979, p. 22)

The Burrell-Morgan four paradigms often show up in organizational analysis. In the domain of management information systems, "from study to study, the indisputable consensus is that positivism dominates information systems research" (Goles & Hirschheim, 2000, p. 254), as in Figure 3.

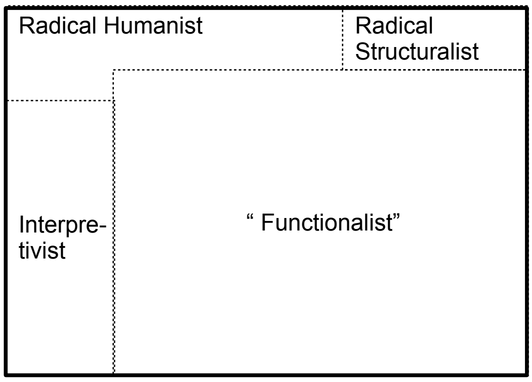

Figure 3: Proportional representation in IS research (Goles & Hirschheim, 2000, p. 254)

Creating a 2x2 matrix does not, however, constitute a paradigmatic framework. With a "linguistic turn" in social theory, an alternative view sees the dimensions of (i) the origin of concepts and problem statements as part of the constitutive process in research, ranging from "local / emergent" research conceptions to "elite / a priori" ones; and (ii) the relation of research practices to the dominant social discourses within the organization studies, from a "consensus discourse" (with reproductive practice in knowledge, social relations and identity) to a "dissensus" that works as a productive practice that disrupts the structures. These can be represented in a 2x2 matrix, but the "mistake" of labelling these as four paradigms is not taken (Deetz, 1996).

Researchers, rather than choosing to operate within a single paradigm, can investigate the variety of modes of rationality. Multiparadigm inquiry contrasts with modern and postmodern stances in Table 1.

Table 1: Alternative approaches to inquiry (Lewis & Kelemen, 2002, p. 254)

	Modern	*Multiparadigm*	*Postmodern*
Ideology	**Centering** Focus on authorship, promote chosen voices, beliefs and issues. Sharpen selective focus	**Accommodating** Value divergent paradigm lenses Explore paradox and plurality	**De-centering** Stress fluctuating and fragmented discourses Accentuate difference and uncertainty
Ontology	**Strong** States of being Entities are distinct, determinant and comprehensible	**Stratified** Multiple dimensions Expose interplay of entities and processes	**Weak** Processes of becoming Meanings are indeterminant, in constant flux and transformation
Epistemology	**Restricted** Employ paradigm prescriptions systematically Construct cohesive representations to advance paradigm development	**Pluralist** Apply divergent paradigm lenses Reflect organizational tensions and encourage greater reflexivity	**Eclectic** Use varied methods freely Deconstruct organizational contexts and processes to produce small stories or modest narratives

Modern paradigms focus on cohesive and static representations. Postmodernism has fragmented and fluctuating discourses. Multiparadigm inquiry seeks to employ and link divergent perspectives with two goals: (i) to encourage greater awareness of theoretical alternatives and thereby facilitate discourse and/or inquiry across paradigms; and (ii) to foster greater understandings of organizational plurality and paradox (Lewis & Kelemen, 2002, p. 258).

2. Where have (and might have) (1960s-2010s) paradigms influenced generative pattern language?

A pattern language initiative may be as ambitious as the books that have taken a decade to complete, or as practical as a project language (Motohashi, Hanyuda, & Nakano, 2013). A group or community may implicitly or explicitly have a paradigm that is internally consistent and externally valid to varying degrees. The universe of works on pattern language – and its influences -- date back to the mid 1960s. Some notable books and journals articles published over that period are listed as exemplars of alternative views.

2.1 Over 50 years, Christopher Alexander and coauthors evolved concepts

Christopher Alexander was undoubtedly a chief driver behind the popularization of pattern language. As a researcher, however, his writing and language gradually evolved.

In 1964, *Notes on the Synthesis of Form* focused on the “process of design” and “goodness of fit” (Alexander, 1964).

In 1965, “A City is Not a Tree” described “natural cities” in contrast with “artificial cities” and introduced the mathematical form of a “semilattice” (Alexander, 1966).

In 1967, “Pattern Manual” was a charter for The Center for Environmental Structure (CES) at Berkeley, describing its activities in (i) publication, distribution and criticism of patterns; (ii) design and invention of patterns; and (iii) basic research. The immediate and future plans named initial staff and associates, with an expectation of two years for the center to become organized and self-sufficient. A pattern format was proposed as a hypothesis, with examples of (i) locating house numbers in a residential zone from a moving car, and (ii) encouraging the formation of social groups by organizing rooms around common lounges or corridors. “Each pattern statement contains a number of <u>parts</u> and describes the spatial relations among those parts” (Alexander et al., 1967, p. 11).

In 1968, “Systems Generating Systems” was published following a commission of the Systemat exhibit display for the Aspen Design Conference, written in 1967 as a monograph for Inland Steel. This article introduced the ties between systems thinking and its application to built environments.

> 1. There are two ideas hidden in the word system: the idea of a *system* as a whole and the idea of a *generating* system.
>
> 2. A *system as a whole* is not an object but a way of looking at an object. It focuses on some holistic property which can only be understood as a product of interaction among parts.
>
> 3. A *generating system* is not a view of a single thing. It is a kit of parts, with rules about the way these parts may be combined.
>
> 4. Almost every ‘system as a whole’ is generated by a ‘generating system’. If we wish to make things which function as ‘wholes’ we shall have to invent generating systems to create them. [....]
>
> In a properly functioning building, the building and the people in it together form a whole: a social, human whole. The building systems which have so far been created do not in this sense generate wholes at all. (Alexander, 1968, p. 605)

This 1967 writing on “Systems Generating Systems” can be fleshed out in the broader context of *The Timeless Way of Building* (Alexander, 1979) and the 1983 publication of interviews with Alexander (Grabow, 1983) in the distinctions between generative systems and non-generative systems (Steenson, 2014).

In 1968, *A Pattern Language which Generates Multi-Service Centers* demonstrates how a pattern language could become instantiated differently for a variety of sites and circumstances. These community facilities were to provide a variety of special services to citizens, particularly in low-income communities. Eight buildings generated the by pattern language were described for Hunts Point, San Francisco, Brooklyn, Bowery, Phoenix, Newark, and two in Harlem (Alexander et al., 1968).

In 1975, *The Oregon Experiment* was named as third volume from the Center for Environmental Structure, yet the first book released. The experiment was a master plan for the University of Oregon, presented as a practical manifestation. This community was unique, with a single owner (The State of Oregon) and a single, centralized budget. The book outline six principles of implementation:

- (i) organic order, with the whole emerging gradually from local acts;
- (ii) participation, with decisions in the hands of the users;
- (iii) piecemeal growth, with construction weighted overwhelmingly towards small projects;
- (iv) patterns, as communally adopted planning principles;
- (v) diagnosis of well-being of the whole, through annual detailing of spaces alive and dead; and
- (vi) coordination, through a funding process regulating the stream of individual projects put forward by users (Alexander, Silverstein, Angel, Ishikawa, & Abrams, 1975, p. 6).

In 1977, *A Pattern Language: Towns, Buildings, Construction* was released as the second volume from the CES. The language starts with the largest scale patterns defining a town or community (1. Independent Regions ... 94. Sleeping in Public), then groups of buildings and individual buildings on the land (95. Building Complex ... 204 Secret Place), and lastly a building from the rough scheme of spaces (205. Structure Follows Social Spaces ... 253. Things from Your Life). Starting with 253 patterns, "Choosing a Language for Your Project" suggests "taking patterns from this language we have printed here, and then by adding patterns of your own" (Alexander et al., 1977, p. Xxxviii).

In 1979, *The Timeless Way of Building*, named as the first volume from the CES, was released after the other two. The *Timeless Way* "is a process which brings order out of nothing but ourselves; it cannot be attained, but it will happen of its own accord, if we will only let it" (Alexander, 1979, p. 3). The *Quality without a Name* "is the root criterion of life and spirit in a man, a town, a building, or a wilderness. This quality is objective and precise, but it cannot be named" (Alexander, 1979, p. 19). The *Gate* is a living pattern language that must be built. The *Way* is the practice relating the pattern language common to a group of people "who adopt it as the basis for the reconstruction of their world" (Alexander, 1979, p. 353). The *Kernel of the Way* "has nothing, in the end, to do with languages", but instead "merely release the fundamental order which is native to us" (Alexander, 1979, p. 531).

In 1999, "The Origins of Pattern Theory" was published in IEEE Software (Alexander, 1999), based on a 1996 talk at the OOPSLA conference of the Association for Computing Machinery (Alexander, 1996b). Alexander described the pattern language for built environments has having three essential features: (i) a moral component; (ii) an aim of creating morphological coherence; and (iii) generativity to produce living structure. He said that he hadn't seen evidence of either the moral component nor generativity in software pattern theory. The content previewed work forthcoming in *The Nature of Order*.

From 2002 to 2005, the four volumes of *The Nature of Order* were released. Book One, *The Phenomenon of Life* described the phenomenon of life; wholeness and the theory of centers; and fifteen fundamental properties (i.e. "objects and buildings which have life all have certain identifiable structural characteristics. The same geometric features keep showing up in them, again and again") (Alexander, 2002a, p. 144). Alexander's definition of the nature of order, "unites the objective and subjective, it shows us that order as the foundation of all things ... is both rooted in substance and rooted in feeling, is at once objective in a scientific sense, yet all also substantial in the sense of poetry, in the sense of feelings which make us human, which make us in secret and vulnerable thoughts, just what we are" (Alexander, 2002a, p. 298).

Book Two, *The Process of Creating Life*, proposes a dynamic view of order. Instead of being concerned with design as a static structure, becoming is an essential feature of the building process. Mentioning David Bohm, Alexander describes a process "which I mean by 'emergence of the wholeness' and by 'emergence of the configuration from the wholeness'" (Alexander, 2002b, p. 19) becomes described as "unfolding wholeness". Structure-preserving transformation preserves the balance as a system of centers modifies other centers within the whole. "The wholeness is changed, since the relative strength of centers has changed. The centers have not changed greatly, only slightly. Yet this slight change changes the wholeness of the entire configuration, and by our making the intensification, a new structure more highly differentiated that before has been created" (Alexander, 2002b, p. 53).

Book Three, *A Vision of a Living World*, shows examples of "buildings, neighbourhoods, gardens, public space, wilderness, house, construction details, color, ornament" (Alexander, 2005, p. 5).

Book Four, *The Luminous Ground*, deals with the inner meaning for the builder. "My hypothesis is this: that all value depends on a structure in which each center, the life of each center, approaches this simple, forgotten, remembered, unremembered "I" ... that in the living work of each center, in some degree, is a connection to this "I", or self ...." (Alexander, 2004a, p. 3). "I believe it is in the nature of matter, that it is soaked through with self or "I" (Alexander, 2004a, p. 8).

In 2003, a short overview for a scientific audience was released as "New Concepts in Complexity Theory", and released on natureoforder.com web site. "The beauty of naturally occurring patterns and forms has rarely been discussed by scientists as a practical matter, as something needing to be explained, and as part of science itself. Yet the fifteen transformations, if indeed they provide a primary thrust in the engine of evolution, and in the many engines of pattern formation, give us a way of understanding how beauty -- aesthetics -- plays a concrete role, not an incidental role, in the formation of the universe. (Alexander, 2003, p. 21).

In 2004, "Sustainability and Morphogenesis: The Birth of a Living World" was presented as a Schumacher Lecture in the UK. The speech asserted three empirical propositions:

> (1) When environments are built by morphogenesis they will of their own accord become sustainable.
>
> (2) Among strategies for dealing with sustainability, morphogenesis alone can deal with ALL the issues of sustainability together.
>
> (3) This effort will reorient all our efforts, and achieve the deeper agenda of the sustainable movement, in a form that is more profoundly satisfying, and more in keeping with our social and cultural aspirations (Alexander, 2004b, p. 3).

In 2005, version 17 of a draft of "Generative Codes" was posted on the livingneighborhoods.org web site. A "generative feature of urban codes – that the code must contain a description of the approximate sequence in which the elements of the code are best brought forth in order that a living while whole may unfold successfully from them – is natural and ordinary" (Alexander, Schmidt, Hanson, & Mehaffy, 2005, p. 3).

In 2007, "Empirical Findings from *The Nature of Order*" presented 59 "results that summarize 30 years of observation and experience", with 25 judged as both testable and tested marked as "demonstrated" (Alexander, 2007). In result 16, Alexander notes that as a replacement for the term "structure-preserving transformation" used in the Book 2, he has adopted "the more expressive term 'wholeness-extending'".

The 2015 publication of *The Battle for the Life and Beauty of the Earth: A Struggle Between Two World-Systems* describes the methods and experiences of building the Eishin School in Japan circa 1985. The practices of creating a pattern language, dealing with construction budget and then laying out the buildings on the land (rather than drawing blueprints) is a thick description of dealing with stakeholders and the physicality in the built environment.

Tracing through this long history of works, some general themes are consistent, yet the language to describe them evolves. The later work aimed towards developing stronger theoretical foundations raises questions about the implicit paradigm in Alexander's philosophy of science.

2.2 At Berkeley, Churchman, Rittel and Alexander taught in the 1960s-1970s

In the 1960s and 1970s, Christopher Alexander was not the only professor interested in the challenges of ill-structured problems. The Design Methods Movement was "the result of post war optimism and a belief that making design more scientific would help to produce a better world. However, it became clear that real world problems were 'wicked', requiring a different approach from the application of scientific techniques developed during World War II" (Langrish, 2016, p. 1). Centered on a "Conference on Design Methods" in London in 1962, the key figures were considered to be Bruce Archer, John Chris Jones, Christopher Alexander and Horst Rittel. By 1971, Alexander had resigned from the board of editors of the DMG Newsletter, because he felt that the intent to create well-defined procedures which would enable people to design better buildings had been lost. "I believe passionately in the idea that people should design buildings for themselves. In other words, not only that they should be *involved* in the buildings that are for them but that they should actually help *design* them" (Alexander & Jacobson, 1971).

At the University of California Berkeley, there were some other major figures just on campus. A student at that time could observe the interactions.

> Both Alexander and Rittel were part of what at the time was called the 'design methods' movement in architecture, worked and taught in the same building, and did talk and were seen walking off to have lunch together. Churchman was teaching in the Business School a few minutes down on the way to the center of campus (Mann, 2017).

Christopher Alexander, Horst Rittel and West Churchman were all influential thinkers at the intersection of design and systems thinking, and on the faculty at Berkeley.

C. West Churchman (1913-2004) joined Berkeley in 1957, cofounding the graduate programs in Operations Research at the School of Business Administration (Ulrich, 2009). From 1964 to 1970, he was Associate Director and Research Philosopher at the Space Sciences Laboratory. That influence would show up in publications by his students, including *The Subjective Side of Science: A Philosophical Inquiry Into the Psychology of the Apollo*

Moon Scientists (Ian I. Mitroff, 1974), *Creating a dialectical social science: Concepts, methods, and models* (Ian I. Mitroff & Mason, 1981), and *Challenging strategic planning assumptions: theory, cases, and techniques* (Mason & Mitroff, 1981). After his retirement in 1981, Churchman continued to teach Peace & Conflict Studies at the university.

Horst W.J. Rittel (1930-1990) came to Berkeley in 1963, into the College of Environmental Design. That college had come together in 1959 with the three schools of architecture, landscape architecture and urban planning orchestrated into a single organization by dean William Wurster. Having previously taught at Hochschule für Gestaltung (HfG) Ulm, Rittel introduced cybernetics into operations research at Berkeley (Rith & Dubberly, 2007). Rittel was a key figure in the Design Methods Movement internationally, and was a cofounder of the Design Methods Group at Berkeley. By 1972, a second-generation design method was being proposed:

> *Protzen*: Then the change in attitude calls for different procedures, and these procedures if developed you would call ‘second-generation’ procedures?
>
> *Rittel*: Yes. And these methods are characterized by a number of traits, one of them being that the design process is not considered to be a sequence of activities that are pretty well defined and that are carried through one after the other, like ‘understand the problem, collect information, analyse information, synthesize, decide’, and so on; and another being that you cannot understand the problem without having a concept of the solution in mind; and that you cannot gather information meaningfully unless you have understood the problem but that you cannot understand the problem without information without it – in other words that all the categories of the typical design model of the first generation do not exist any more, and that ll those difficulties that these phases are supposed to deal with occur all the time in a fashion which depends on the state of the understanding of the problem. The second feature of the second generation is that it is argumentative, as I explained before. That means that the statement made are systematically challenged in order to expose them to viewpoints of the different sides, and the structure of the process becomes one of alternating steps on the micro-level; that means the generation of solution specifications towards end statement and subjecting them discussion of their pros and cons. This process in turn raises questions of a factual nature and questions of a deontic or ought-to-be-nature. In the treatment of such factual or deontic questions in the course of dealing with an issue many of the traditional methods of the first generation may become tools, used to support or attack any of the positions taken. You might make a cost-benefit study as an argument against somebody else’s deontic statements, or you might use an operations research model in order to support a prediction or argue against somebody’s prediction. However, I wouldn’t say that the methods are the same just in a different arrangement and with a different attitude, but that there are some methods particular to second generation, and that these are in particular the rules for structuring arguments, and that these are new, and not in the group of methods developed in the first generation (Rittel, Grant, & Protzen, 1972).

In 1974, Rittel was appointed to the Institut für Grundlagen der Planung at Universität Stuttgart. He continued travelling back and forth between Germany and California as “an international commuter splitting his time between the two institutions” (Churchman, Protzen, & Webber, 1992).

Christopher Alexander (born 1936) joined the faculty of the College of Environmental Design at Berkeley in 1963, also at the invitation of dean William Wurster. In 1967, he cofounded the Center for Environmental Structure with the staff and associates listed as: Tamas I. Bartha, Alan M. Hershdorfer, Sara Ishikawa, Roslyn Lindheim, Marvin L. Manheim, Harris Savin, Murray Silverstein, Sim Van der Ryn, plus himself (Alexander et al., 1967, p. 6). In 1998, Alexander officially retired from the university. He received a grant from Bill Joy at Sun Microsystems to complete *The Nature of Order* (Brown, 2000).

While the majority of today's scholars read and cite Alexander, Rittel and Churchman as independent luminaries, the graduate students at Berkeley in the 1970s with an interest in planning could easily cross over from the colleges of environmental design and business administration. Those alumni went on to full careers, and the majority are in retirement. In the 21st century, we now have the opportunity to not start from scratch, but to stand on the shoulders of their continued learning.

An open system of knowledge should recognize (and potentially reconcile, adopt and/or embrace) parallel research in alternative streams of thought.

2.3 Architecture ~ problem-seeking; Design ~ problem-solving

Pattern language originated in the planning and construction of built environments. Thus, distinctions between architecture and design may clarify the premises on which conceptualization takes place.

In 1969, *Problem Seeking: New directions in architectural programming* described distinctions that were in use at an architecture firm in Texas, as drawn in Figure 4.

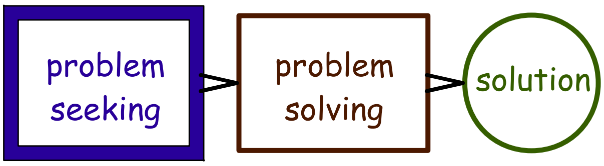

Figure 4: Programming is problem seeking; design is problem solving (Peña & Focke, 1969)

> Programming is a specialized and often misunderstood term. It is "a statement of an *architectural problem* and the requirements to be met in offering a solution". While the term is used with other descriptive adjectives such as *computer* programming, *educational* programming, *functional* programming, etc., in this report, programming is used to refer only to architectural programming.
>
> Why programming? The client has a project with many unidentified sub-problems. The architect must define the client's total problem.
>
> Design is problem solving; programming is problem seeking. The end of the programming process is a statement of the total problem; such a statement is the element that joins programming and design. The "total problem" then serves to point up constituent problems, in terms of four considerations, those of form, function, economy and time. The aim of the programming is to provide a sound basis for effective design. The State of the Problem represents the essense and the uniqueness of the project. Furthermore, it suggests the solution to the problem by defining the main issues and giving direction to the designer (Peña & Focke, 1969, p. 3).

The original illustration of a linear process may be unfortunate, as some circularity between problem solving and problem seeking may be conceptually interpreted between the lines.

In 1971, "Some Principles for Design of an Educational System for Design" outlines the kind of knowledge that guides architects and designers.

> Instrumental knowledge relates three kinds of entities with each other. These three entities, which can be described as variable which can assume different values are:
>
> 1. *Performance variables*, which express desired characteristics of the object under design, and in terms of which the object will be evaluated ("construction cost", "esthetic appeal", "overall quality" and the like).
> 2. *Design variables*, which describe the possibilities of the designer, his range of choice, his design variables, the things he has some control over ("height of ceiling", "shape of door knob", "type of heating", and the like).
> 3. Context variables, which are those factors affecting the object to be designed but not controlled by the designer "land price", "height of people", "likelihood of earthquakes", "type of eating habits", and so forth).
>
> If we call (O) a specification of the performance of an object O, (i.e. a statement about the observed, desired, or predicted performance of O), if we write D(O) for a specification of design variables of O (as intended or actual), and if C(O) describes a particular constellation of the context of O, then the general format for an item of instrumental knowledge becomes (in the simplest case):
>
> "Under context C(O), design configuration D(O) will lead to performance P(O)". (Rittel, 1971, p. 20)

In addition, the design process and the structure of the designer's knowledge has some intellectual difficulties that recur.

1. To assess the worthwhileness of a project.
2. To determine the appropriate level of a problem.
3. To determine the nature of the solution.
4. To construct and evaluation system.
5. To anticipate the context of the object.
6. To identify a relevant solution space.
7. To constrain the solution space.
8. To construct a system of functional relationships which connect design variables, context variables and performance variables with each other.
9. To find an appropriate solution in the solution space.
10. To avoid undesired side- and after-effects of a planning.
11. To implement a solution proposal.
12. To test the results (Rittel, 1971, pp. 21–23).

As a basic dilemma of human existence, reasoning is challenged by anticipating action, and nonrational spontaneous action is irresponsible.

In 2006, a distinction between architecture and design in software has become a conventional wisdom.

> The aforementioned Dick Gabriel posed a question to the Hillside Group: what is design? Here's my reply to him:
>
> As a noun, design is the named (although sometimes unnamable) structure or behavior of a system whose presence resolves or contributes to the resolution of a force or forces on that system. A design thus represents one point in a potential decision space. A design may be singular (representing a leaf decision) or it may be collective (representing a set of other decisions).
>
> As a verb, design is the activity of making such decisions. Given a large set of forces, a relatively malleable set of materials, and a large landscape upon which to play, the resulting decision space may be large and complex. As such, there is a science associated with design (empirical analysis can point us to optimal regions or exact points in this design space) as well as an art (within the degrees of freedom that range beyond an empirical decision; there are opportunities for elegance, beauty, simplicity, novelty, and cleverness).
>
> A few related terms:
>
> **All architecture is design but not all design is architecture**. Architecture represents the significant design decisions that shape a system, where significant is measured by cost of change (Booch, 2006).

In this paradigm of architecture and design, there are distinctions made between the two. In comparison, the Alexandrian paradigm doesn't emphasize the same distinction, although there is a gradient of abstraction from patterns in a language through to completion of the finished built environment.

2.4 Wicked problems led to IBIS and argumentation schemes

The phrase "wicked problems" was first related to social issues associated with planning that included urban environments.

In 1967, "Wicked Problems" were first surfaced in the journal *Management Science* as a result of conversations occurring at Berkeley.

> Professor Horst Rittel of the University of California Architecture Department has suggested in a recent seminar that the term "wicked problem" refer to that class of social system problems which are ill-formulated, where the information is confusing, where there are many clients and decision makers with conflicting values, and where the ramifications in the whole system are thoroughly confusing. The adjective "wicked" is supposed to describe the mischievous and even evil quality of these problems, where proposed "solutions" often turn out to be worse than the symptoms. [....]
>
> Rittel suggested that there are various attempts to "tame" these wicked problems, among which must be counted the efforts of operations research and management science. Sometimes the taming consists of trying to generate an aura of good feeling or consensus. Sometimes, as in OR, it consists of "carving off" a piece of the problem and finding a rational and feasible solution to this piece. In the latter case, it is up to someone else (presumably a manager) to handle the untamed part. [....]

> The moral principle is this: whoever attempts to tame a part of a wicked problem, but not the whole, is morally wrong (Churchman, 1967, pp. B141–B142).

In 1970, “Issues as Elements of Information Systems” was published as a working paper from the Institute of Urban and Regional Development at Berkeley.

> Issue-Based Information Systems (IBIS) are meant to support coordination and planning of political decision processes. IBIS guides the identification, structuring and settling of issues raised by problem-solving groups, and provides information pertinent to the discourse. It is linked to conventional documentation systems but also activates other sources. Element of the system are topics, issues, questions of fact, positions, arguments and model problems (Kunz & Rittel, 1970, p. 1).

In 1973, “Dilemmas in a General Theory of Planning” formalized wicked problems with goal formation and problem definition.

> There are at least ten distinguishing properties of planning-type problems, i.e. wicked ones .... We use the term “wicked” in a meaning akin to that of “malignant” (in contrast to “benign”) or “vicious” (like a circle) or “tricky” (like a leprechaun) or “aggressive” (like a lion, in contrast to the docility of a lamb). [....]
>
> 1. There is no definitive formulation of a wicked problem ....
>
> 2. Wicked problems have no stopping rule ....
>
> 3. Solutions to wicked problems are not true-or-false, but good-or-bad ....
>
> 4. There is no immediate and no ultimate test of a solution to a wicked problem ....
>
> 5. Every solution to a wicked problem is a "one-shot operation"; because there is no opportunity to learn by trial-and-error, every attempt counts significantly ....
>
> 6. Wicked problems do not have an enumerable (or an exhaustively describable) set of potential solutions, nor is there a well-described set of permissible operations that may be incorporated into the plan ....
>
> 7. Every wicked problem is essentially unique ....
>
> 8. Every wicked problem can be considered to be a symptom of another problem ....
>
> 9. The existence of a discrepancy representing a wicked problem can be explained in numerous ways. The choice of explanation determines the nature of the problem's resolution ....
>
> 10. The planner has no right to be wrong ....
>
> What was once a clear-cut win-win strategy, that had the status of a near-truism, has now become a source of contentious differences among subpublics. [....]
>
> Our point ... is that diverse values are held by different groups of individuals -- that what satisfies one may be abhorrent to another, that what comprises problem-solution for one is problem-generation for another. Under such circumstances, and in the absence of an overriding social theory or an overriding social ethic, there is no gainsaying which group is right and which should have its ends served (Rittel & Webber, 1973, pp. 160–169).

In 1980, “APIS: A Concept for an Argumentative Planning Information System” reported on progress on IBIS for planning.

> APIS (Argumentative Planning Information System) ... is specifically tailed to a particular class of planning situations. It is meant to be useful to in the context of government

planning, on local, state, national or international levels. It is not intended to support the treatment of problems of physical planning (such as the design of buildings, engineering design, or managerial planning. APIS is laid out for policy planning, the design of legislation, the development of government programs, and similar tasks (Rittel, 1980, p. 3).

In 1987, "gIBIS: A Hypertext Tool of Team Design Deliberation" extended Rittel's work with technology.

> The IBIS model focuses on the articulation of the key Issues in the design problem. Each Issue can have many Positions, where a Position is a statement or assertion which resolves the Issue. Often Positions will be mutually exclusive of one another, but the method does not support this. Each of an Issue's Positions, in turn, may have one or more Arguments which either support that Position or object to it. [....]
>
> There were three technological themes guiding our design of gIBIS. The first was an interest in exploring the capture of design rationale .... The second was an interest in supporting computer mediated teamwork, and particularly the various kinds of design conversations that might be carried on via networked computers, a la email or news .... Thirdly, we wanted an application in which we would have a sufficiently large information base to investigate issues regarding the navigation (i.e. search and browsing) of very large and loosely structured information spaces (Conklin & Begeman, 1987, p. 248).

In 2003, "Facilitated Hypertext for Collective Sensemaking: 15 years on from gIBIS" brought together researchers who had worked on Compendium for a reflection.

> With the benefit of 15 years' hindsight, we can see the failure of so many DR [design rationale] systems to be adopted as symptomatic of the more general problem of fostering new kinds of 'literacy' in real working environments. Pursuing Engelbart's goal of "augmenting human intellect", we describe the Compendium approach to collective sensemaking, which demonstrates the impact that a facilitator can have on the learning and adoption problems that plagued earlier DR systems. We also describe how conventional documents and modelling notations can be morphed into and out of Compendium's 'native hypertext' in order to support other modes of working across diverse communities of practice (Conklin, Selvin, Shum, & Sierhuis, 2001, p. 1).

In this paradigm on wicked problems, collaborative planning including political positioning has been structured with argumentation schemes and facilitated with graphical electronic technologies. In comparison, the Alexandrian paradigm uses rough sketches that are materialized into physical environments that can be continually evaluated with stakeholders.

2.5 Systems approach led to assumption surfacing, postnormal science

The systems approach has its roots in the development of General Systems Theory, and has evolved with an appreciation of inquiring systems.

In 1956, "General Systems Theory: The Skeleton of Science" described model-building somewhere between generalized constructions (pure mathematics) and specialized theories (disciplines).

> [The quest of General Systems Theory is] for a body of systematic theoretical constructs which will discuss the general relationships of the empirical world. It does not seek, of course, to establish a single, self-contained "general theory of practically everything" which will replace all the special theories of particular disciplines. Such a theory would be almost without content, for we always pay for generality by sacrificing content, and all we can say about practically everything is almost nothing. Somewhere however between the specific that has no meaning and the general that has no content there must be, for each purpose and at each level of abstraction, an optimum degree of generality (Boulding, 1956, pp. 197–198).

In 1968, *The Systems Approach* described a shift from operations research, where the perspective of scientists broadened.

> Systems are made up of sets of components that work together for the overall objective of the whole. The systems approach is simply a way of thinking about these total systems and their components. We have already seen one essential feature of this way of thinking, namely, that thinking enters in at the very outset of dictating the manner in which we describe what it is we are planing to do (Churchman, 1968, pp. 11–12).

In 1971, *The Design of Inquiring Systems* was targeted at interests of philosophical issues of design, of inquiry, and of social systems.

> We are specifically interested in the design of systems, i.e., of structures that have organized components. [....]
>
> Inquiry is an activity which produces knowledge (Churchman, 1971, pp. 7–8).

In 1979, *The Systems Approach and its Enemies* tackled the challenges with improving systems as a whole.

> Common to all these enemies is that none of them accepts the reality of the "whole system": we do not exist in such a system. Furthermore, in the case of morality, religion, and aesthetics, at least a part of our reality as human is not "in" any system, and yet it plays a central role in our lives.
>
> To me these enemies provide a powerful way of learning about the systems approach, precisely because they enable the rational mind to step outside itself and to observe itself (from the vantage point of the enemies). [....]
>
> We must face the reality that the enemies offer: what's really happening in the human world is politics, or morality, or religion, or aesthetics. This confrontation with reality is totally different from the rational approach, because the reality of the enemies cannot be conceptualized, approximated, or measured (Churchman, 1979, pp. 24–53).

In 1981, *Challenging Strategic Planning Assumptions*, where decision-making under conditions of uncertainty and turbulence are not only dealt with effectively, but potentially as opportunities.

> [Our] theory of real world problem solving attempts to incorporate each of these ideals:
>
> 1. **Democracy** The ideal that all parties have a right and a capacity to participate in problem solving and to benefit from the result.

2. **Scientific method** The ideal that the most appropriate scientific techniques should be used to produce knowledge for problem solving.
3. **Empiricism** The ideal that all problem solving should have a grounded experiential referent in the real world.
4. **Evolution** The idea that all problems are couched in a dynamic context and that they change and evolve through time. Real world problem solving is eternally restless.

> Further, we draw on a fifth ideal, holism – the ideal that all problems are linked to others and must be dealt with as a whole. This does not mean that one must solve all problems simultaneously, clearly an impossible demand. Rather, it means that one must attempt to consider as large a problem set as possible in the formulation of any particular problem (Mason & Mitroff, 1981, p. 20).

In 1986, "Reflections on Systems and their Models" distinctions were drawn between different types of systems and different ways of representing them.

> There are three basic types of systems and models of them, and a meta-system: one that contains all three types as parts of it (see Table [2]).

Table 2: Types of systems and models

Systems and models	Parts	Whole
Deterministic	Not purposeful	Not purposeful
Animated	Not purposeful	Purposeful
Social	Purposeful	Purposeful
Ecological	Purposeful	Not purposeful

(1) Deterministic: systems and models in which neither the parts nor the whole are purposeful.

(2) Animated: systems and models in which the whole is purposeful but the parts are not.

(3) Social: systems and models in which both the parts and the whole are purposeful.

> These three types of system form a hierarchy in the following sense: animated systems have deterministic systems as their parts. In addition, some of them can create and use deterministic systems, but not vice versa. Social systems have animated systems as their parts. All three types of system are contained in ecological systems, some of whose parts are purposeful but not the whole. For example, Earth is an ecological system that has no purpose of its own but contains social and animate systems that do, and deterministic systems that don't (Ackoff & Gharajedaghi, 1996, p. 14).

In 2004, "The Post-Normal Science of Precaution" sees the scientific system as in a crisis of confidence, legitimacy and power.

> Now we can discern the emergence of two approaches to the understanding and management of the scientific enterprise. The first is what might be called ''mainstream science,'' which carries on with inherited attitudes and assumptions of inevitable and irresistible progress, in spite of the drastic changes in the new conditions. It proudly maintains the reductionist tradition of Western science, in which complex systems are

assumed to be capable of being taken apart, studied in their elements and then reassembled. In this old paradigm, systemic properties are deemed incapable of scientific study and are therefore to be ignored. [....]

The contrasting approach to science, still in the very early stages of development, could be called ‘precautionary’, since it is usually concerned with reacting to the unintended harmful effects of progress. Its style is ‘post-normal’; it lies at the contested interfaces of science and policy. It addresses issues where, typically, facts are uncertain, values in dispute, stakes high and decisions urgent (Ravetz, 2004, p. 349).

In this paradigm around the systems approach, questions on methods for collectively designing systems and validating their appropriateness under changing conditions are brought forward. In comparison, the Alexandrian paradigm takes a more idealized approach, and relies on architectural expertise to facilitate the design and construction of a built environment.

2.6 Pattern language has rise in agile, groups, public sphere

Beyond built physical environments, the pattern language approach has been implemented in a variety of other domains, with varying levels of adherence to the basic ideas.

In 1987, the first patterns were written by Ward Cunningham and Kent Beck at the Tektronix Semiconductor Test Systems group, and reported at the OOPLSA conference. Bruce Anderson gave talks in 1990, and the four others that would become known as the Gang of Four – Eric Gamma, Richard Helm, Ralph Johnson and John Vlissides – met at an OOPSLA 1991 workshop.

In August of 1993, KentBeck and GradyBooch sponsored a mountain retreat in Colorado where a group of us converged on foundations for software patterns. WardCunningham, RalphJohnson, KenAuer, HalHildebrand, GradyBooch, KentBeck and JimCoplien struggled with Alexander's ideas and our own experiences to forge a marriage of objects and patterns. We agreed that we were ready to build on ErichGamma's foundation work studying object-oriented patterns, to use patterns in a generative way in the sense that ChristopherAlexander uses patterns for urban planning and building architecture. We then used the term *generative* to mean *creational* to distinguish them from *Gamma patterns* that captured observations.

Bruce again held his workshop at OOPSLA '93, this time with patterns in the workshop title and prominently on the agenda.

The HillsideGroup met again in early April 1994 to *plan* the first PLoP conference. We wanted something really wacky and unusual, but most of us felt (and were willing to take) the risk that goes with new things. That was RichardGabriel's first time with us. He exhorted us all to go into PLoP with confidence and act as though we knew what we were doing (Cunningham, 2000).

In 1994, the *Portland Pattern Repository* was created as the first wiki, enabling internal references that would map to hypertext links (Cunningham, 1994).

In 1995, *Design Patterns: Elements of Reusable Object-Oriented Software* was published, and became one of the best known works in computer science.

The purpose of this book is to record experience in designing object-oriented as **design patterns**. Each design pattern systematically names, explains and evaluates an

> important and recurring design in object-oriented systems. Our goal is to capture design experience in a form that people can use effectively. To this end, we have documented some of the most important design patterns and present them as a catalog. [....]
>
> For this book we have concentrated on patterns at a certain level of abstraction. *Design patterns* are not about designs such as linked lists and hash tables that can be encoded in classes and reused as is. Nor are they complex, domain-specific designs for an entire application or subsystem. The design patterns in this book are descriptions of *communicating objects and classes that are customized to solve a general design problem in a particular context*. (Gamma, Helm, Johnson, & Vlissides, 1995, pp. 2–3).

The catalog is this book are considered “Gamma patterns”, and thus a not strong adoption of the Alexandrian approach.

> A generative pattern is one of the KindsOfPatterns. It is first a pattern; a solution to a problem in a context. In the early days of patterns, we used the term generative to mean creational. But a closer reading of Alexander shows that by generative, he means something that leads to emergent behavior.
>
> Generative patterns work indirectly; they work on the underlying structure of a problem (which may not be manifest in the problem) rather than attacking the problem directly. Good design patterns are like that: they encode the deep structure (in the Senge sense) of a solution and its associated forces, rather than cataloging a solution.
>
> We can contrast a Generative Pattern with a GammaPattern, which is not generative. (That doesn't make them bad, just different. Much of the software visualization work going on in the industry is all about Gamma patterns) (Coplien, 1995).

In 1995, *Pattern Languages of Program Design* became the first in the series of proceedings from the meetings of the Hillside Group (Coplien & Schmidt, 1995).

In 1996, *Patterns of Software: Tales from the Software Community*, the foreword was written by Christopher Alexander, on first reading the article that became the chapter “The Bed Game, Rugs and Beauty”.

> What was fascinating to me, indeed quite astonishing, was that in his essay I found out that a computer scientist, not known to me, and whom I had never met, seemed to understand more about what I had done and was trying to do in my own field than my own colleagues who are architects (Alexander, 1996a, p. v).

Encouraged by the cross-appropriation into software development, Alexander also recognized that the writing on The Nature of Order (which would not be officially published for another 6 years) would potentially be left to a subsequent book by Gabriel.

> As I reached the end of Patterns of Software, I realized that my story as told by Richard Gabriel -- was incomplete in a number of important ways, which may have direct bearing on the computer scientists struggling with just these questions.
>
> Richard Gabriel focuses, very much, on *unsolved* problems, on the struggle and the path to almost ineluctable difficulties in architecture. He does not comment, perhaps enough, on the fact that these problems are solvable in practice, in fact are being solved right now. The geometry of life, in buildings, which I wrote about for 25 years, in order to attain it, is finally being attained, just now (Alexander, 1996a, p. vii).

As an influential figure on the software development community, Richard Gabriel wrote and compiled a series of essays from the position of "critic-at-large".

> One of my goals in writing these essays was to bring out the reality of commercial software development and to help people realize that right now software development -- except when a project essentially is creating a near variant of an existing program -- is in a state where the artifact desired is brand new and its construction is unknown, and therefore the means to approach its construction is unknown and possibly difficult to ascertain; and, furthermore, a group of people is trying to work together -- maybe for the first time -- to accomplish it (Gabriel, 1996a, pp. xv–xvi).

In trying to understand Alexander's writing, a strong contribution is made in the chapter on quality without a name.

> Alexander proposes some words to describe the quality without a name, but even though he feels they point the reader in a direction that helps comprehension, these words ultimately confuse. The words are *alive*, *whole*, *comfortable*, *free, exact*, *egoless*, and *eternal*. I'll go through all of them to try to explain the quality without a name [....]
>
> What is revolutionary about Alexander is that he is resuming the quest for an understanding of objective quality that science and philosophy abandoned in the modern era. In the seventeenth and eighteenth centuries, a tension developed in which mind and matter were separated by science and philosophy. From this came the separation of fact and value. After the separation, a fact had no value associated with it, a fact could not be good or bad, it just was. Science, then, tried to find theories that explained things as they were and no longer sought what was good or beautiful about things. That is, we no longer sought the objective characteristics of beauty, which is where Alexander started his quest (Gabriel, 1996b, pp. 36–39).

In 2001, the "Manifesto for Agile Software Development" was released by 17 signatories. They include key members at the dawn of the Hillside Group (e.g. Kent Beck, Ward Cunningham), an author of a position paper on Scrum Development Process at OOPSLA'95 (Schwaber, 1997), and the founding chairman of the Scrum Foundation in 2008 (Jeff Sutherland). The original document was published on the Internet, and continues to be available:

Manifesto for Agile Software Development

We are uncovering better ways of developing software by doing it and helping others do it. Through this work we have come to value:

Individuals and interactions over processes and tools

Working software over comprehensive documentation

Customer collaboration over contract negotiation

Responding to change over following a plan

That is, while there is value in the items on the right, we value the items on the left more (Beck et al., 2001).

The manifesto included "Twelve Principles of Agile Software". Ten years later, a subsequent meeting produced a history with reflections (Cockburn, 2011), and proposals for a revision (Ambler, 2011).

In 2004, *Organizational Patterns of Agile Software Development* reflected a change in social style for developing software.

> Our interest in this book is what software development has learned about itself from an organizational and social perspective. [...] Now we are in the fourth style: one that breaks down hierarchy, that features dynamic social structures and communication paths, and that values immediacy. This fourth style often bears the label "agile," but that is just one of many characterizations of a broad new way of developing software that has emerged over the past decade. [....]
>
> Patterns provide a way to capture both the broad, invariant practices of socially built artifacts as well as the specialized practices of individual disciplines, along with an understanding of how those practices build on each other (Coplien & Harrison, 2004, pp. 2–3).

This work continued with a Scrum summit associated with the VikingPLoP conference in 2008 (Bjørnvig & Coplien, 2008). The Scrum Pattern Community has held official workshops every year since 2010, and collaborates on a wiki at scrumplop.org. By 2016, there were plans to formalize the web site content as a forthcoming *A Scrum Book* (Ramos, den Hollander, Heasman, & Coplien, 2016).

In 2008, *Liberating Voices: A Pattern Language for Communication Revolution* proposed a new model of social change, whereby information and communications could be used to address urgent social issues collaboratively.

> This book presents the first draft of a language for a communications revolution. It is intended to be an everyday guide for people who are working to shape a better future. .... [The] objective of this book and the broader pattern language project is to characterize this unruly and uncoordinated revolution by integrating the totality of their efforts. [....]
>
> The structure of our language acknowledges the enormity of this world: a world that can be seen as comprising three deeply interconnected and enmeshed worlds of distinctive as well as shared characteristics. The first world is physical and measurable and ultimately provides our sustenance. It includes natural elements like air, sunlight, water and soil, as well as physical products of humankind like roads, buildings, books, pesticides and bombs. The second world is the world of individual and social communications and interpretation, a world also complex – and messy. Within this world, some people learn and grow wise; others may become banal, stupid, uncaring and brutal. The third world is the world of the knowledge that we collectively create and recreate over time, a world of theories, disciplines, data, language, policies, institutions, laws and taboos (Schuler, 2008, pp. 2–3).

This work began in 2001 with grants from the National Science Foundation, with the Public Sphere Project at publicsphereproject.org, drawing 85 contributors on the pattern language. In 2012, pattern cards based on the content in the 2008 book were released for free download. In 2014, a new research and action community network was formed focusing on "Collection Action for the Public Good", extended the principles from the prior work.

In 2012, the Group Pattern Language Project released the *Group Works* desk of 100 full-colour cards (of 91 patterns, plus 9 category cards).

> The Group Works deck ... names what skilled facilitators and other participants do to make things work. The content is more specific than values and less specific than tips and techniques, cutting across existing methodologies with a designer's eye to capture the patterns that repeat. The deck can be used to plan sessions, reflect on and debrief them, provide guidance, and share responsibility for making the process go well. It has the potential to provide a common reference point for practitioners, and serve as a framework and learning tool for those studying the field (Group Pattern Language Project, 2013).

The project was started as "A Pattern Language for Group Conversation" in 2008 at we.riseup.net/pattern_language. This became the "Pattern Language for Group Process" at grouppatternlanguage.org through 2012, at which time the Group Works deck was released and the domain migrated to groupworksdeck.org.

The paradigm espoused by these projects aim to adopt the Alexandrian philosophy faithfully, despite the application of techniques beyond built physical environments. Christopher Alexander himself acknowledges the heritage and general spirit, while claiming limited knowledge about the domains.

2.7 Ecological epistemology led to interaction design + affordances

If taking pattern language beyond the built physical environment is to be seriously regrounded in the changing philosophy in the design profession, the impacts of shifts in ecological epistemology and interaction design should be recognized.

In 1972, *Steps to an Ecology of Mind* introduced many ideas that would only become labelled as ecological epistemology after the death of Gregory Bateson.

> The essays, spread over thirty-five years, combine to propose a new way of thinking about ideas and about those aggregates of ideas which I call "minds." This way of thinking I call the "ecology of mind," or the ecology of ideas. It is a science which does not yet exist as an organized body of theory or knowledge. [....]
>
> The questions which the book raises are ecological: How do ideas interact? Is there some sort of natural selection which determines the survival of some ideas and the extinction or death of others? What sort of economics limits the multiplicity of ideas in a given region of mind? What are the necessary conditions for stability (or survival) of such a system or subsystem? [...]
>
> It was only in late 1969 that I became fully conscious of what I had been doing. With the writing of the Korzybski Lecture, "Form, Substance, and Difference," I found that in my work with primitive peoples, schizophrenia, biological symmetry, and in my discontent with the conventional theories of evolution and learning, I had identified a widely scattered set of bench marks or points of reference from which a new scientific territory could be defined. These bench marks I have called "steps" in the title of the book (Bateson, 1972, p. xvii).

In 1979, *The Ecological Approach to Visual Perception* starts from the environment to be perceived by an animal, and leads into a philosophy that is neither objectivist or subjectivist, but instead in the complementary relation.

> The *affordances* of the environment are what it *offers* the animal, what it *provides* or *furnishes*, either for good or ill. The verb to *afford* is found in the dictionary, but the

noun *affordance* is not. I have made it up. I mean by it something that refers to both the environment and the animal in a way no existing term does. It implies the complementarity of the animal and the environment. The antecedents of the term and the history of the concept will be treated later; for the present, let us consider examples of an affordance. [p. 127]

If a terrestrial surface is nearly horizontal (instead of slanted), nearly flat (instead of convex or concave), and sufficiently extended (relative to the size of the animal) and if its substance is rigid (relative to the weight of the animal), then the surface *affords support*. It is a surface of support, and we call it a substratum, ground, or floor. It is stand-on-able, permitting an upright posture for quadrupeds and bipeds. It is therefore walk-on-able and run-over-able. It is not sink-into-able like a surface of water or a swamp, that is, not for heavy terrestrial animals. Support for water bugs is different.

Note that the four properties listed -- horizontal, flat, extended, and rigid – would be physical properties of a surface if they were measured with the scales and standard units used in physics. As an affordance of support for a species of animal, however, they have to be measured *relative to the animal*. They are unique for that animal. They are not just abstract physical properties. They have unity relative to the posture and behavior of the animal being considered. So an affordance cannot be measured as we measure in physics. [....]

In architecture a niche is a place that is suitable for a piece of statuary, a place into which the object fits. In ecology a niche is a setting of environmental features that are suitable for an animal, into which it fits metaphorically.

An important fact about the affordances of the environment is that they are in a sense objective, real, and physical, unlike values and meanings, which are often supposed to be subjective, phenomenal, and mental. But, actually, an affordance is neither an objective property nor a subjective property; or it is both if you like. An affordance cuts across the dichotomy of subjective-objective and helps us to understand its inadequacy. It is equally a fact of the environment and a fact of behavior. It is both physical and psychical, yet neither. An affordance points both ways, to the environment and to the observer (Gibson, 1979, pp. 127–129).

A 1999 report of "Putting It All Together – Towards a Pattern Language for Interaction Design: A CHI 97 Workshop" related the rationale, structure and process of the meeting.

Interaction design is becoming more diverse in that a wider range of people are becoming involved in it. Within CHI, it is well accepted that anthropologists, psychologists, and visual designers, as well as engineers and computer scientists, have roles to play in systems design. [...] While the multidisciplinary nature of interaction design brings much richness, it is also challenging because no common perspective, set of practices, or theoretical orientation can be assumed.

Another factor driving the diversification of interaction design is customization. As systems become increasingly customizable, more and more design -- in the sense of front end creation, application programming, and software configuration -- is being done in-house. [....] And, in many cases, these participants lack formal training in design, and hence any common perspective or language.

A Possible Solution: Pattern Languages

So, we have a rapidly expanding game: more players and more technology projected onto workplaces which we are learning more and more about. This increasing complexity and diversity can be source of richness, or of chaos. Thus, we need to explore ways of dealing with the increasing complexity and diversity of the interaction design field. This workshop explored one approach to putting it all together through a common language. Our model is the work of Christopher Alexander and his colleagues who over the last few decades have looked at what works and what doesn't work in architecture and urban design. The basic approach is to closely examine particular cases, attempt to identify recurring patterns and integrate them into a language of relatively concrete patterns (Bayle et al., 1998, p. 17).

In addition to the findings in the 1998 report, addition research was subsequently published as "Lingua Francas for design: sacred places and pattern languages" (Erickson, 2000).

In 1999, "Affordance, Conventions, and Design" traced the development of CHI (Computer Human Interaction) from the publication of *The Psychology of Everyday Things* in 1998, with a reissuing in the same year with the changed title of *The Design of Everyday Things*.

> In POET, I argued that understanding how to operate a novel device had three major dimensions: conceptual models, constraints, and affordances. These three concepts have had a mixed reception.
>
> To me, the most important part of a successful design is the underlying conceptual model. This is the hard part of design: formulating an appropriate conceptual model and then assuring that everything else be consistent with it. I see lots of token acceptance of this idea, but far too little serious work. The power of constraints has largely been ignored.
>
> To my great surprise, the concept of affordance was adopted by the design community, especially graphical and industrial design. Alas, yes, the concept has caught on, but not always with complete understanding. My fault: I was really talking about perceived affordances, which are not at all the same as real ones.
>
> **Perceived Affordance**
>
> POET was about "perceived affordance." When I get around to revising POET, I will make a global change, replacing all instances of the word "affordance" with the phrase "perceived affordance." The designer cares more about what actions the user perceives to be possible than what is true. Moreover, affordances, both real and perceived, play very different roles in physical products than they do in the world of screen-based products. In the latter case, affordances play a relatively minor role: cultural conventions are much more important. More on that in a moment. In product design, where one deals with real, physical objects, there can be both real and perceived affordances, and the two sets need not be the same.
>
> In graphical, screen-based interfaces, the designer primarily can control only perceived affordances. The computer system already comes with built-in physical affordances. The computer, with its keyboard, display screen, pointing device, and selection buttons (e.g., mouse buttons) affords pointing, touching, looking, and clicking on every pixel of the screen. Most of this affordance is of little interest for the purpose of the application under design (Norman, 1999, p. 39).

Norman's interpretation of affordances as described by Gibson challenges definitions in an alternative paradigm.

> The word *affordance* was coined by the perceptual psychologist J. J. Gibson to refer to the actionable properties between the world and an actor (a person or animal). To Gibson, affordances are relationships. They exist naturally: they do not have to be visible, known, or desirable.
>
> I originally hated the idea: it didn't make sense. I cared about processing mechanisms, and Gibson waved them off as irrelevant (Norman, 1999, p. 39).

The specification of "exist naturally" by Norman is counter to the recognition of "man's alteration of the natural environment" by Gibson.

> In the last few thousand years, as everybody now realizes, the very face of the earth has been modified by man. The layout of surfaces has been changed, by cutting, clearing, leveling, paving, and building. Natural deserts and mountains, swamps and rivers, forests and plains still exist, but they are being encroached upon and reshaped by man-made layouts. Moreover, the substances of the environment have been partly converted from the natural materials of the earth into various kinds of artificial materials such as bronze, iron, concrete, and bread. Even the medium of the environment – the air for us and the water for fish-is becoming slowly altered despite the restorative cycles that yielded a steady state for millions of years prior to man.
>
> Why has man changed the shapes and substances of his environment? To change what it affords him. He has made more available what benefits him and less pressing what injures him. In making life easier for himself, of course, he has made life harder for most of the other animals. Over the millennia, he has made it easier for himself to get food, easier to keep warm, easier to see at night, easier to get about, and easier to train his offspring.
>
> This is not a new environment -- an artificial environment distinct from the natural environment -- but the same old environment modified by man. It is a mistake to separate the natural from the artificial as if there were two environments; artifacts have to be manufactured from natural substances. It is also a mistake to separate the cultural environment from the natural environment, as if there were a world of mental products distinct from the world of material products. There is only one world, however diverse, and all animals live in it, although we human animals have altered it to suit ourselves. We have done so wastefully, thoughtlessly, and if we do not mend our to ways, fatally (Gibson, 1979, pp. 129–130).

This relational view of affordances is also consistent with "social affordances" in the CSCW (computer supported cooperative work) community (citing Gibson, but not Norman).

> Our working definition of a social affordance is *the relationship between the properties of an object and the social characteristics of a group that enable particular kinds of interaction among members of that group*. For example, consider a door that opens out into a busy hallway. If a person opens the door quickly, it may strike someone entering from the other direction. One possible solution is to put a glass window in the door. The glass window addresses the problem at two levels. At the level of individual perception, the glass makes a person on the other side visible (i.e., the window affords seeing through it to a sighted person). At the social level, since people are socialized to not strike others with doors, they will refrain from doing so if given the chance. Furthermore, not only can the potential door opener see through the window, but the person on the other side can see as well, and thus there is shared knowledge of the situation (e.g., 'I

> know that you know that I know'). As a consequence, the door opener will be held accountable for her actions. This accountability, which arises from the optical properties of glass, human perceptual abilities, and the social rules of the culture, is an example of what we call a social affordance (Bradner, Kellogg, & Erickson, 1999, p. 154).

In 2000, *Perception of the Environment: Essays on livelihood, dwelling and skill* extended the work on ecological epistemology into ecological anthropology.

> Gibson wanted to know how people come to perceive the environment around them. The majority of psychologists, at least at the time when Gibson was writing, assumed that they did so by constructing representations of the world inside their heads. It was supposed that the mind got to work on the raw material of experience, consisting of sensations of light, sound, pressure on the skin, and so on, organising it into an internal model which, in turn, could serve as a guide to subsequent action. The mind, then, was conceived as a kind of data-processing device, akin to a digital computer, and the problem for the psychologist was to figure out how it worked. But Gibson's approach was quite different. It was to throw out the idea, that has been with us since the time of Descartes, of the mind as a distinct organ that is capable of operating upon the bodily data of sense. Perception, Gibson argued, is not the achievement of a mind in a body, but of the organism as a whole in its environment, and is tantamount to the organism's own exploratory movement through the world. If mind is anywhere, then, it is not 'inside the head' rather than 'out there' in the world. To the contrary, it is immanent in the network of sensory pathways that are set up by virtue of the perceiver's immersion in his or her environment. Reading Gibson, I was reminded of the teaching of that notorious maverick of anthropology, Gregory Bateson. The mind, Bateson had always insisted, is not limited by the skin. Could not an ecological approach to perception provide the link I was looking for, between the biological life of the organism in its environment and the cultural life of the mind in society?
>
> The issue for me, at the time, was to find a way of formulating this link that could also resolve what I felt to be a deep-rooted problem in my own work. Setting out from the complementarity thesis, I had argued that human beings must simultaneously be constituted both as organisms within systems of ecological relations, and as persons within systems of social relations. The critical task for anthropology, it seemed, was to understand the reciprocal interplay between the two kinds of system, social and ecological (Ingold, 2000, pp. 2–3).

In 2011, Being Alive: Essays on Movement, Knowledge and Description provided more of the philosophical background supporting an ecological approach to anthropology. In reflection of research conducted over the past decade:

> I therefore had to leave the mainstream to find my answers. In psychology I turned to the work of James Gibson, whose ecological approach to perception, developed in 1950s and 1960s, was explicitly opposed to the prevailing paradigm of cognitivism. And in ethology I rediscovered the long neglected, pre-war writings of the Estonian-born pioneer of biosemiotics, Jakob von Uexküll. Both seemed to offer a radically alternative way of thinking about meaning, finding it not in the correspondence between an external world and its interior representation, but in the immediate coupling of perception and action. Yet, as I also found, behind this commonality lay significant differences (Ingold, 2011, p. 77).

This stance would lead to positioning away from Martin Heidegger, and towards Gilles Deleuze.

> Can there be any escape from this shuttling back and forth between enclosure and disclosure, between an ecology of the real and a phenomenology of experience? So long as we suppose that life is fully encompassed in the relations between one thing and another -- between the animal and its environment or the being and its world -- we are bound to have to begin with a separation, siding either with the environment vis-à-vis its inhabitants or with the being vis-à-vis its world. A more radical alternative, however, would be to reverse Heidegger's priorities: that is, to celebrate the openness inherent in the animal's very captivation by its environment. This is the openness of a life that will not be contained, that overflows any boundaries that might be thrown around it, threading its way like the roots and runners of a rhizome through whatever clefts and fissures leave room for growth and movement .... Once again, we can take our cue from von Uexküll, who compares the world of nature to polyphonic music, in which the life of every creature is equivalent to a melody in counterpoint .... [....]
>
> Life, for Deleuze, is lived not within a perimeter but along lines. He calls them 'lines of flight', or sometimes 'lines of becoming'. Such lines prise an opening, even as they bind the animal with its world. Every species, indeed every individual has its own particular line, or rather bundle of lines .... Critically, however, these lines do not connect .... (Ingold, 2011, p. 83)

The term "meshwork" is borrowed from Henri Lefebvre, and contrasted with the actor network of Bruno Latour. The dissolution of boundary between organism and environment is consistent with anthropologist Gregory Bateson, as well as cognitive scientist Andy Clark.

In this paradigm based in an ecological epistemology, living in space is more fully appreciated as living in time, "On Human Correspondence" (i.e. co-responding) alongside each other (as well as animals and other trails in the world) (Ingold, 2017). This philosophy acknowledges, but goes well beyond "Building, Dwelling, Thinking" (originally in German as "Bauen Wohnen Denken" in 1951) (Heidegger, 1971). In the Alexandrian paradigm, time is better handled in *The Timeless Way of Building* than in *A Pattern Language*, but a different view of the world is taken in *The Nature of Order*.

2.8 Hierarchy theory led to panarchy and resilience science

In a pattern language, relations between patterns in the physical built environment typically begin from the largest scales, down to the smaller scales.

> The patterns are ordered, beginning with the very largest, for regions and towns, then working down through neighborhoods, clusters of buildings, buildings, rooms and alcoves, ending finally with details of construction.
>
> This order, which is presented as a straight linear sequence, is essential to the way the language works. [....] What is most important about this sequence, is that it is based on the connections between the patterns. Each pattern is connected to certain "larger" patterns which come above it in the language; and to certain "smaller" patterns which come below it in the language. The pattern helps to complete those larger patterns which are "above" it, and is itself completed by those smaller pat- terns which are "below" it (Alexander et al., 1977, p. xii).

In the systems sciences, this ordering is recognized through hierarchy theory, which has become a foundation for panarchy and resilience science.

In 1982, *Hierarchy: Perspectives for Ecological Complexity* recognized that theoretical work for ecological systems was not as well developed as those for biological systems.

> ... complexity is something that needs more than an ad hoc treatment.
>
> We see most important complexity as related to the interaction of different levels of organization; in order to give complexity proper account in our scientific models, those models are almost required to be hierarchical. We suggest that there is something about either our facility for observation or that which generates our observations which gives patterns that generally remain opaque unless we model using hierarchies. By hierarchy is understood a system of behavioral interconnections wherein the higher levels constrain and control the lower levels to various degrees depending on the time constants of the behavior. [....] Since bulkier structures in biology generally behave more slowly, not only do slow entities constrain fast, but also large entities usually constrain small. Sometimes the lower levels of the hierarchy are nested inside and in aggregate make up the higher levels (cells and tissues), but sometimes this is not the case (ecological consumers and resources). In the nested and non-nested cases, complexity comes from the nonlinearity and asymmetry of an entity affecting while also being affected by its environment. The environment is a higher level, and it responds more slowly that entities it constrains. For all hierarchies there is complexity associated with the relationship between the rate-independence of the constraint itself and the rate-dependence of the dynamical interaction of the constrained entities (parts in a nested structure. In the non-nested case there is further complexity in spontaneous behavior coming from undefined extra degrees of freedom at both the higher and the lower levels. Complexity need have little to do with the number of variables (Allen & Starr, 1982, pp. xiii–xiv).

While these definitions are centered for application in ecologies, they can also be applied to other types of systems.

> The ideas collected here come from that part of general systems theory which is beyond the mechanistic cybernetic approach. [...] This approach views system theory not just as a tool for solving problems already defined, but as a conceptual framework within which one might develop new ideas about biology (Allen & Starr, 1982, p. 4).

In 1984, How Buildings Learn: What Happens After They're Built extended the work based in hierarchy theory into a more popularized form with built environments.

> The leading theorist – practically the only theorist – of change rate in buildings in Frank Duffy .... He distinguishes four layers, which he calls Shell, Services, Scenery and Set. [...]
>
> I've taken the liberty of expanding Duffy's "four S's" -- which are oriented toward interior work in commercial buildings – into a slightly revised, general-purpose "six S's":
>
> - SITE – This is the geographic setting, the urban location, and the legally defined lot, whose boundaries and context outlast generations of ephemeral buildings. "Site is eternal," Duffy agrees.
> - STRUCTURE – The foundation and load-bearing elements are perilous and expensive to change, so people don't. There *are* the building. Structural life

ranges from 30 to 300 years (but few buildings make it past 60, for other reasons).

- SKIN – Exterior surfaces now change every 20 years or so, to keep up with fashion or technology, or for wholesale repair. Recent focus on energy costs has led to re-engineered Skins that are air-tight and better insulated.
- SERVICES – These are the working guts of a building communications wiring, electrical wiring, plumbing, sprinkler system, HVAC (heating, ventilating, and air conditioning), and moving parts like elevators and escalators. They wear out or obsolesce every 7 to 15 years. Many builds are demolished early if their outdated systems are too deeply embedded to replace easily.
- SPACE PLAN – The interior layout – where walls, ceilings, floors, and doors go. Turbulent commercial space can change every 3 years or so, exceptionally quiet homes might wait 30 years.
- STUFF – Chairs, desks, phones, pictures; kitchen appliances, lamps, hair brushes; all the things that twitch around daily to monthly. Furniture is called *mobilia* in Italian for good reason.

> Duffy's time-layered perspective is fundamental to understanding how buildings actually behave. The 6-S sequence is precisely followed in both design and construction. [.....]
>
> The layering also defines how a building relates to people. Organizational levels of responsibility match the pace levels. [....]
>
> Buildings rule us via their time layering at least as much as we rule them, and in a surprising way. This idea comes from Robert V. O'Neill's *A Hierarchical Concept of Ecosystems*. O'Neill and his co-authors noted that ecosystems could be better understood by observing the rates of change of different components. [....] The insight is this: "*The dynamics of the system will be dominated by the slow components, with the rapid components simply following along*" (O'Neill, DeAngelis, Waide, & Allen, 1986, p. 98). Slow constrains quick; slow controls quick (Brand, 1994, pp. 12–17).

This book was complemented and popularized with a BBC television documentary series. These "shearing layers" of change would eventually be relabelled as "pacing layers" (Brand, 1999).

In 2003, *Panarchy: Understanding Transformations in Human and Natural Systems* would extend hierarchy theory to understand cycles of adaptive change.

> The theory that we develop must of necessity transcend boundaries of scale and discipline. It must be capable of organizing our understanding of economic, ecological, and institutional systems. And it must explain situations where all three types of systems interact. The cross-scale, interdisciplinary, and dynamic nature of the theory has lead [sic] us to con the term *panarchy* for it. Its essential focus is to rationalize the interplay between change and persistence, between the predictable and unpredictable. Thus, we drew upon the Greek god Pan to capture an image of unpredictable change and upon notions of hierarchies across scale to represent structures that sustain experiments, test results, and allow adaptive evolution (Holling, Gunderson, & Ludwig, 2002, p. 5).

In 2004, "Resilience, Adaptability and Transformability in Social-ecological Systems" formalized some definitions that had been developed within the Resilience Alliance.

> Resilience is the capacity of a system to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure, identity, and feedbacks. As amplified below, the focus is on the dynamics of the system when it is disturbed far from its modal state. The notion of speed of return to equilibrium ... leads to what has been termed "engineering resilience" ... and, although related to one aspect of "ecological resilience," cannot be considered as the measure of resilience. Because of the possibility of multiple stable states, when considering the extent to which a system can be changed, return time doesn't measure all of the ways in which a system may fail -- permanently or temporarily -- to retain essential functions. It is also important to bear in mind that "systems" consist of nested dynamics operating at particular organizational scales -- "sub-systems," as it were, of households to villages to nations, trees to patches to landscapes (Walker, Holling, Carpenter, & Kinzig, 2004, p. 2).

In 2015, "Regime Shifts in the Anthropocene: Drivers, Risks, and Resilience" shifted research from theory into analyzing a scientific database at regimeshifts.org.

> Research on regime shifts has typically focused on theoretical models ..., empirical evidence of regime shifts ..., or potential early warning signals ..... These approaches require in-depth knowledge of the causal structure of the system or high-quality temporal data, leading to a focus on the analysis of particular cases of regime shifts. Here we complement this work by synthesizing and comparing different types of regime shifts in terms of global change impacts and opportunities for management. Our aim is to understand: i) What are the main drivers of regime shifts globally? ii) What are their most common impacts on ecosystem services? And, iii) what can be done to manage or avoid them? (Rocha, Peterson, & Biggs, 2015, p. 2)

In this paradigm, relationships between hierarchy, resilience and regime shifts are appreciated with cross-scale effects over time. These foundations in biology and ecology can expand the Alexandrian research into complexity based primarily in physics.

2.9 Interactive value is in the shift to a service economy

New insight into value has come as the world has moved from the economics of scarcity towards an economics of plenty.

In 1994, *Designing Interactive Strategy: From Value Chain to Value Constellation* portrayed changes in markets and in business. Co-produced value is a shift from the traditional view o value added.

> In 1967 Thompson describe three types of relationships between parts of an organization. The most simple is one in what termed a 'pooled' relationship, in which the different parts each contribute to form a whole. The second type of relationship is what he called 'sequential': sections of an organization produce parts which are then inputted into another part. The dynamics of this type of organizational relationship are very similar to the value chain process as described by Porter. Finally, Thompson described the 'reciprocal' relationship, the most complex of the three. In this case, the outputs of each section of the organization become inputs to the sections from which they get their own inputs. [....]
>
> Applying Thompson's categories to the system of value-creating actors, we can see that the value chain covers the fist two types of relationships. It does not, however, provide the conceptual framework to describe the more complex interaction among different

actors which liquidification and density, through the removal of temporal and spatial constraint, have brought to bear upon their interfaces: the 'reciprocal relationship'.

Co-production is the term we use to describe the 'reciprocal' relationships between actors which characterize the service economy (Normann & Ramírez, 1994, p. 30).

As an alternative to centering on products (or services) alone, a definition of offerings is proposed.

The distinction made in the industrial economy between 'products' and 'services' obeyed the following logic: activities packaged into physical goods were more readily amenable to the scale economics of mass production of that era. They were, in effect, an efficient way of storing activities by sharing the cost their creation represented among many price-carrying manifestations which could be matched by as many revenue-generating customers. Service activities were less easy to design so as to benefit from such economics; scale was achieved when they were 'productified', as in the case of trust or unit funds which were found to efficiently 'productivity' costly financial advice in many distinct (if identical) units which were price carrying, and which could be individually sold to many individual revenue-generating customers. [....]

... all relationships between economic actors are manifested in offerings. An offering engages each economic actor participating in a commercial relationship with others in multiple activities. Offerings organize activities along several dimensions:

(1) *In time*, as they store past activities and simultaneously entail a code for potential future activity;

(2) *In space or location*, geographically grounding the simultaneity of activities characteristic of the current technological era and the sequentiality of the past; and

(3) *In terms of the relationships among actors* involved in the co-production of value in the offering. It is in this sense that offerings create and define social systems. Offering designers must address the question of how different actors' activities are to be configured for optimum value creation: who does what, when, where, and with whom?

The total activity set which an offering assumes is constantly being 'unbundled' and 'rebundled' in innovative ways ... (Normann & Ramírez, 1994, pp. 50–53).

In 2004, "Evolving to a New Dominant Logic for Marketing" oriented towards the service economy with a shift from operand resources to operant resources.

Constantin and Lusch (1994) define *operand resources* as resources on which an operation or act is performed to produce an effect, and they compare operand resources with *operant resources*, which are employed to act on operand resources (and other operant resources). [...] A goods-centered dominant logic developed in which the operand resources were considered primary. A firm (or nation) had factors of production (largely operand resources) and a technology (an operant resource), which had value to the extent that the firm could convert its operand resources into outputs at a low cost. Customers, like resources, became something to be captured or acted on ....

Operant resources are resources that produce effects (Constantin and Lusch 1994). The relative role of operant resources began to shift in the late twentieth century as

> humans began to realize that skills and knowledge were the most important types of resources. [....]
>
> Operant resources are often invisible and intangible; often they are core competences or organizational processes. They are likely to be dynamic and infinite and not static and finite, as is usually the case with operand resources. Because operant resources produce effects, they enable humans both to multiply the value of natural resources and to create additional operant resources. [....]
>
> The service-centered view of marketing implies that marketing is a continuous series of social and economic processes that is largely focused on operant resources with which the firm is constantly striving to make better value propositions than its competitors. In a free enterprise system, the firm primarily knows whether it is making better value propositions from the feedback it receives from the marketplace in terms of firm financial performance. Because firms can always do better at serving customers and improving financial performance, the service-centered view of marketing perceives marketing as a continuous learning process (directed at improving operant resources) (Vargo & Lusch, 2004, pp. 2–5).

In 2007, "Steps Towards a Science of Service Systems" proposed research and education oriented towards a world with information services growing rapidly.

> The service economy refers to the service sector, one of three main economic categories, in addition to service activities performed in the extractive and manufacturing sectors. The growth of the service sector has resulted in part from the specialization and outsourcing of service activities performed inside manufacturing firms (for example, design, maintenance, human re- sources, customer contact specialists). According to a recent National Academy of Engineering report, the service sector accounts for more than 80 percent of the US gross domestic product, employs a large and growing share of the science and engineering workforce, and is the primary user of IT. [....]
>
> ... we're cultivating an interdisciplinary effort called Service Science, Management, and Engineering -- the application of scientific, management, and engineering disciplines to tasks that one organization (service provider) beneficially performs for and with another (service client). SSME aims to understand how an organization can invest effectively to create service innovations and to realize more predictable outcomes. With information and business services the service economy's fastest-growing segments -- and with the rise of Web services, service-oriented architectures (SOA), and self-service systems -- we see a strong relationship between the study of service systems and the more established study of computational systems (Spohrer, Maglio, Bailey, & Gruhl, 2007, pp. 71–72).

In 2011, The Science of Service Systems was a volume of articles presenting multidisciplinary and multisectoral perspectives on the nature of service systems.

> What types of entities interact to co-create value? Service systems are such entities, be they individuals, firms, or nations. Service science is a transdisciplinary approach to study, improve, create, scale, and innovate in service .... We think of service as value cocreation – broadly speaking, as useful change that results from communication, planning, or other purposeful and knowledge-intensive interactions between distinct

> service system entities, such as individuals, firms, and nations .... And so we think of service science as the systematic search for principles and approaches that can help understand and improve all kinds of value cocreation between interacting service systems .... Value cocreation interactions fall into two categories. Value-proposition-based interactions deal with access rights to resources that measurable benefit stakeholders, while governance-mechanism-based interactions deal with dispute resolution mechanisms needed to clean-up failures and debug shortcomings of the first type of interactions (Demirkan, Spohrer, & Krishna, 2011, pp. 1–2).

This paradigm sees value creation as an interaction beyond the coproduction of outputs (as offerings, products and/or services). In the Alexandrian philosophy, preferences are seen as objective, and therefore shared across a collection of individuals.

3. Why might a pattern language project or community pay more attention to its paradigm?

In The Nature of Order, Christopher Alexander sought to deepen the scientific foundations underlying his approach to architecting and constructing built physical environments. As others target the use of pattern language for alternative contexts – of which the social change of the PURPLSOC community is beyond Alexander's scope – the external validity and internal consistency within the espoused paradigm may break down.

3.1 Is an assumed paradigm leading you to making errors?

The application of pattern language beyond built physical environments can lead to errors in a variety of types, as shows in Table 3.

Table 3: Types of Errors

Type 1 error	False positive	Finding a (statistical) relation that isn't real
Type 2 error	False negative	Missing a (statistical) relation that is real
Type 3 error	Tricking ourselves	Unintentional error of solving the wrong problems precisely (through ignorance, faulty education or unreflective practice)
Type 4 error	Tricking errors	Intentions error of solving wrong problems (through malice, ideology, overzealousness, self-righteousness, wrongdoing)

> The basic ideas behind the Type One and Type Two Errors are easy to grasp. Suppose one is interested in testing whether a new drug is better than an old one a treating headaches. In the process of giving the new drug and old drug to two evenly matched groups ... two errors can be made.
>
> First, one can conclude wrongly that the new drug is better than the old one when actually the old one is better or equal to the new one. This is known as the Type One Error, or E1. E1 is akin to saying that there's a meaningful difference between the two drugs when there is not.
>
> Second, one can also conclude wrongly that the old drug is better than the new one when in fact the new one is better. This is known as Type Two Error, or E2. E2 is akin to saying that there is *not* a meaningful difference between the drugs when there is. [...]
>
> The Type Three Error is the unintentional error of solving the wrong problems precisely

> [The] Type 4 error is the intentional error of solving the wrong problems. [...]
>
> The Type Three Error is primarily the result of ignorance, a narrow and fault education, and unreflective practice.
>
> In contrast, the Type Four Error is the result of deliberate malice, narrow ideology, overzealousness, a sense of self-righteousness, and wrongdoing. ... [Every] Type Four Error is invariably political or has strong political elements ... (Ian I. Mitroff & Silvers, 2010, pp. 3–5).

Starting off a pattern language initiative without reflecting on the implicit assumptions (or presumptions) from the paradigm is a blindness.

> If they can get you asking the wrong questions, they don't have to worry about the answers (Pynchon, 1973).

Without a strong appreciation of the underlying paradigm, the vector of progress on improving a pattern language will be ambiguous.

3.2 Learn from Christopher Alexander's later descriptions based on practices

The concepts and language presented by Christopher Alexander, since *Notes on the Synthesis of Form* in 1964, have evolved so that establishing a coherent paradigm is a challenge.

With The Nature of Order as a highly theoretical work that can be difficult to comprehend, another alternative is proposed. Rather than working from theory to practice, working from practice to theory may be fruitful. Christopher Alexander's latest (and potentially last) work may illuminate methods that can be used practically, as outlined in Table 4.

Table 4: Alexandrian methods for built environments

(i) Pattern language for the community	(a) Interviewing on hopes and dreams
	(b) Making a first sketch of a pattern language
	(c) Making a first draft pattern from teachers' comments
	(d) Checking seven principles for the completeness of the languages
	(e) Refining the language
	(f) Creating pattern language as a list of key centers
(ii) Construction budget	(a) Making a record of all of the spaces and areas which were defined by the pattern languages
	(b) Trimming all space to available budget, as an average percentage reduction for all items in interior space, and then exterior space
	(c) Asking faculty to re-allocate the spaces, keeping the same trimmed totals, conforming with the available resources
(iii) Reality of the land	(a) Laying out the site plan on the ground
	(b) Finding the two fundamental systems of centers, and combining them
	(c) Visualizing the evolving site plan with marks on the land (e.g. flags)
	(d) Fixing first hardline drawings of detailed positions on the site (position, orientation, dimension
	(e) Judging detailed building positions on the land (with flags)
	(f) Recording the site plan on paper

The larger perspective shows that writing the pattern language is only the first step towards producing a tangible outcome. Reflection on how these steps might or might not be appropriate for the domain chosen in the early stages of a pattern language community could lead members to try a different tack.

3.3 Dialectical assumption analysis is a generative approach

A technique for establishing a better approach to generative pattern language could use the Strategic Assumption Surfacing Technique, outline in Table 5.

Table 5: Steps towards assumption surfacing

Step	Activity	Means for accomplishing
1	Formation of Different Groups	• MAPS (Multivariate Analysis and Participative Structure) Design Technology • Personality Type Technology • Ad Hoc Group Technology • Vested Interests Technology
2	Assumption Surfacing	• Stakeholder Analysis • Assumption Sorting
3	Dialectical Debate between Group Policies and Synthesis	• Assumption Negotiation • Assumptional Decision Theory

> … the environment is more often than not one of constantly changing conditions, uncertainty, and turbulence than that of certainty, stability and predictability. Little wonder that under these conditions problem forming and problem defining become as important, if not more so, than problem solving by means of conventional techniques. […]
>
> Essentially the Dialectic is an adversarial problem forming methodology especially suited to treating intensely ill-structured, i.e., difficult-to-define, issues. It does this by attempting to set up at least two very different (antithetical) and maximally challenging views (definitions, policies) of a problem situation so that everything that one view takes for granted as a basic and reasonable assumption, the other challenges as intensely as it can. [….]
>
> The intent is … to allow the manager to take advantage of a turbulent environment and thereby to convert a problematic situation into an opportunity (I. I. Mitroff, Emshoff, & Kilmann, 1979, pp. 583–584).

Assumption surfacing is seen as a method for ill-structured problems. Incompatible presumptions in the underlying paradigm for generative pattern language can be improved through a focus on the inquiring system.

3.4 Pattern Manual for Service Systems Thinking is explicit in its paradigm

In some respects, this paper serves as an assumption surfacing for the paradigm underlying the “Pattern Manual for Service Systems Thinking” presented at PUARL last year (Ing, 2016). While other pattern languages may not select a similar paradigm, the project should be aware of potential blind spots.

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