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Permaculture Design: On the Practice of Radical Imagination

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Abstract

Permaculture design is a concept that aims at transforming not only agriculture, but also city planning, architecture, development, etc. In short it aims to change human habitats. It is part of a new ecological paradigm that is currently spreading in popularity from the urban gardening movement to various other alternative movements such as the slow movement, sustainable architecture, etc. Permaculture design defines itself as building on systems theory (as formulated in particular by Howard Thomas Odum and Christopher Alexander). However I would like to propose that the afterlife of systems theory as expressed in the concept of permaculture, first developed by Bill Mollison and David Holmgren, should not only be sought in theoretical and analytical discourse. Instead we can understand permaculture as a form of figurative, ecological reasoning; a form of radical imagination drawn from the composite knowledge of a heterogeneous network of actors. Permaculture is thus neither a branch of environmental science nor an environmental political movement. Rather the philosophy of permaculture design questions the division between theory and practice or between rationality and sensibility. In permaculture design, these modes of knowledge are inextricably linked in explorations of patterns.

In this article, I attempt to delineate the ways in which permaculture design is rooted in the practical knowledge of systems. I shall limit myself to exploratory drilling, as it were, in three aspects of permaculture design thought. First, I describe permaculture thought as a form of practical knowledge that generated through a kind of visual thinking in patterns. Second, I describe permaculture thought as a type of thinking in which radical imagination and speculation play an active role. Third, I present permaculture thought as systems theory thought. However it departs from the idea of control inherent to systems theory, drawing instead from the equally popular (and colorful) Gaia hypothesis, which posits Earth as an intelligent, material assembly that modifies thought processes.

Keywords

Permaculture, ecological movement, ecology, system theory, Gaia, intelligencing, wild thinking

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In this article, I attempt to delineate the ways in which permaculture design is rooted in the practical knowledge of systems. I shall limit myself to exploratory drilling, as it were, in three aspects of permaculture design thought. First, I describe permaculture thought as a form of practical knowledge that generated through a kind of visual thinking in patterns. Second, I describe permaculture thought as a type of thinking in which radical imagination and speculation play an active role. Third, I present permaculture thought as systems theory thought. However it departs from the idea of control inherent to systems theory, drawing instead from the equally popular (and colorful) Gaia hypothesis, which posits Earth as an intelligent, material assembly that modifies thought processes.

Axioms of practical knowledge

Bill Mollison, a biogeographer[1] and autodidact born in Australia in 1928, is considered the founding father of the permaculture movement, together with his student David Holmgren.[2] In 1978, Mollison founded the Permaculture Research

[1] Biogeography combines aspects of biological and geographical analysis and mediates between bioecology and geoecology.

[2] Holmgren met Mollison in 1973 at the Environmental Design School in Hobart, Tasmania and became his student. His doctoral thesis on sustainable agriculture became the basis for his famous 1978 book, Permaculture One. Bill Mollison, *Permaculture: A Designers' Manual*

Institute and in 1981 he received the Right Livelihood Award, the alternative Nobel Prize. Mollison's seminal book, *Permaculture: A Designers' Manual*, in which he outlines his novel idea of permanent agriculture, appeared in 1988. Motivated by the growing environmental, social, and political movements of the 1970s, Mollison developed the concept of permaculture as a response to the forceful warnings issued by the Club of Rome in their 1972 book *The Limits to Growth* and to the crisis of 'peak oil', which geologist Marion King Hubbert predicted would occur in 1995.[3] The permaculture concept is not simply an environmental protection measure or an organic farming principle, but rather a form of ecosystem design. As Mollison writes:

> This book is about designing sustainable human settlements, and preserving and extending natural systems. It covers aspects of designing and maintaining a cultivated ecology in any climate […].[4]

Mollison's idea was to design 'natural' ecosystems as they appear in 'nature' permaculture understands itself as a school of design based not on the ingenuity of human's capacity for abstraction, but on 'nature's genius' and on knowledge transfer between different systems via imitation. This is also expressed in the design concept developed by Mollison and Holmgren, which follows what they call the 12 permaculture design principles, based on creating and developing patterns. This principles are 1) Observe and interact; 2) Catch and store energy; 3) Obtain a yield; 4) Apply self-regulation and accept feedback; 5) Use and value renewable resources and services; 6) Produce no waste; 7) Design from patterns to details; 8) Integrate rather than segregate; 9) Use small and slow solutions; 10) Use and value diversity; 11) Use edges and value the marginal; 12) Creatively use and respond to change.[5] All processes within a system are regulated by these principles, which Mollison understands as "axioms".

> Let us look at the sets of principles that govern these systems. These principles, rules and directives are based on the study of natural systems. Axioms are established principles or self-evident

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(Sisters Creek, Tasmania: Tagari Publications, 1988), accessed April 4, 2014, http://de.scribd.com/doc/54165878/Permaculture-A-Designers-Manual-by-Bill-Millison, IXf.

[3] M. King Hubbert, "Nuclear Energy and the Fossil Fuels" (paper presented at the spring meeting of the Southern District, American Petroleum Institute, Plaza Hotel, San Antonio, Texas, March 7-8-9, 1956), accessed April 4, 2014, doi: http://www.hubbertpeak.com/hubbert/1956/1956.pdf.

[4] Mollison, *Permaculture*, forward.

[5] David Holmgren, *Permaculture. Principles and Pathways Beyond Sustainability*. (Hampshire: Permanent Publications, 2002), accessed April 4, 2014. http://library.uniteddiversity.coop/Permaculture/Permaculture-Principles_and_Pathways_Beyond_Sustainability.pdf, VIII.

> truths. A principle is a basic truth, a rule of conduct, a way to proceed. A law is a statement of fact backed up by a set of hypotheses which have proved to be correct or tenable. Theses and hypotheses are ideas offered up for proof or discussion. There are also rules and laws laid down which are neither rules nor laws. They do not pay much attention to defining how they got there. Now I have evolved a set of directives which say: 'Here is a good way to proceed.' It doesn't have anything to do with laws or rules, just principles.[6]

As axioms, they need not be derived or deduced, or even proven. For Mollison, they are natural laws, substantiated by the practice of repeated empirical observation in nature. Permaculture design accords central importance to the position of the observer. The observer watches the constant flux of the ecosystem in a manner of "protracted and thoughtful observation".[7] Observation is the foremost principle of permaculture design.[8]

Pattern: Embodied Knowledge

In permaculture design, the observation of nature is a matter of pattern recognition.

> A process of continuous observation in order to recognize patterns and appreciate details is the foundation of all understanding. Those observed patterns and details are the source for art, science and design. The natural and especially the biological world, provides by far the greatest diversity of patterns and details observable without the aid of complex or expensive technology. Those patterns and details provide us with a great repertoire of models

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[6] Mollison, *Permaculture*, 8.

[7] Ibid., IX. "The philosophy behind permaculture is one of working with, rather than against, nature; of protracted and thoughtful observation rather than protracted and thoughtless action; of looking at systems in all their functions, rather than asking only one yield of them; and of allowing systems to demonstrate their own evolutions." Ibid., IXf.

[8] See for example Mollison, *Permaculture*, 12 and 43; "Observation, the first principle of Permaculture, is the key to making use of succession. Landscapes embody dynamic processes with a history and, to some extent, a future that can be read from the signs observable now. This ability is a critical observational skill that can be developed. Dynamic change in nature and landscape is easily accepted as an intellectual concept, but our direct visual experience of landscape is most commonly a static image or picture in which the past and future are invisible." Holmgren, *Permaculture. Principles and Pathways*, 247.

> and possibilities for the design of low energy human support systems.[9]

Patterns are thus a visual embodiment of nature's knowledge. Permaculture explores, observes and describes these patterns, and then transforms them into various systems. Concrete permaculture design involves dividing landscapes into zones (of daily life: people, machines, animals, houses, etc.) and sectors (present and future energy sources, wilderness, temperature, light sources, etc.). These zones and sectors are investigated for patterns. In the end, the area being landscaped should be designed to best fit a few underlying patterns:

> Patterns are all about us: waves, sand dunes, volcanic landscapes, trees, blocks of buildings, even animal behaviour. If we are to reach an understanding of the basic, underlying patterns of natural phenomena, we will have evolved a powerful tool for design, and found a linking science applicable to many disciplines. For the final act of the designer, once components have been assembled, is to make a sensible pattern assembly of the whole.[10]

The designer thus creates data (patterns) and then works from this basis. Mollison and Holmgren describe the process of permaculture design as one of assembling components to form a pattern:

> Definition of Permaculture Design: Permaculture design is a system of assembling conceptual, material, and strategic components in a pattern which functions to benefit life in all its forms. It seeks to provide a sustainable and secure place for living things on this earth.[11]

Patterns bundle complex knowledge in a visual form. Abstraction and the reduction of complexity are intertwined with imagery and thus imagination. Patterns are 'embodied' systems theory knowledge, as Holmgren says of the myths and legends of the Australian aborigines:

> Further, I believe many of the insights of systems thinking that are difficult to grasp as abstractions are truths that are embodied in the stories and myths of indigenous cultures.[12]

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[9] Holmgren, *Permaculture. Principles and Pathways*, 13.
[10] Mollison, *Permaculture*, 70.
[11] Ibid., 69.
[12] Holmgren, *Permaculture. Principles and Pathways*, XXVI.

Mollison derives the technique of patterning from the aborigines.[13] In his view, patterns as embodied, visualized knowledge are not simply abstractions, but directly transport a complex knowledge of systems:

> Complex systems that work tend to evolve from simple ones that work, so finding the appropriate pattern for that design is more important than understanding all the details of the elements in the system.[14]

Holmgren describes this kind of knowledge transfer as osmosis or 'practical resonance':

> Apart from the ecological energetics of Howard Odum, the influence of systems thinking in my development of Permaculture and its design principles has not come through extensive study of the literature, but more through an osmotic absorption of ideas in the 'cultural ether' which strike a chord with my own experience in Permaculture design.[15]

Holmgren speaks of osmosis in the 'cultural ether' as a form of attaining knowledge. Thus permaculture knowledge is not scientific knowledge derived from systems theory, but axiomatic, practical, visual knowledge gained through osmosis. Mollison adds that permaculture thought within these patterns must be understood as a kind of empathy:

> As the design itself is a function of our understanding of the system, so does the yield also depend upon the degree to which we understand things. It is the intellect that decides all these things, rather than any extrinsic factors. I am not quite sure what the intellect is. I have put it as our ability to understand, which may not be intellectual but empathetical.[16]

Holmgren believes we must relearn the "ability to see, hear and otherwise recognize the patterns of nature".[17] In pattern analysis, taxonomical knowledge is generated though the observations of our senses. The aim is to create deeply subjective taxonomies that are able to work with Borgesian ambiguities. Whether

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[13] Mollison, *Permaculture*, 23; Bill Mollison, *Permaculture Design Course Pamphlet Series*. (Sparr, Florida: Barking Frogs Permaculture, 1981), accessed April 4, 2014, http://www.barkingfrogspermaculture.org /PDC_ALL.pdf, 74; Holmgren, *Permaculture. Principles and Pathways*, 22, 151f.
[14] Holmgren, *Permaculture. Principles and Pathways*, 127.
[15] Ibid., XXVI.
[16] Mollison, *Permaculture*, 9.
[17] Holmgren, *Permaculture. Principles and Pathways*, 128.

or not a pattern is recognized and transferred to other zones or sectors is completely random. For this reason, Mollison describes speculation as a basic modus of permaculture ordering:

Many speculations can arise from one observation! Speculations are a species of hypothesis, a guess about which you can obtain more information. To further examine these speculations, several strategies are open to the observer.[18]

Permaculture design's speculative, fuzzy pattern recognition is drawn from the work of the practical and theoretical architect and systems theorist Christopher Alexander.[19] Alexander understood patterns, unlike models, not as analytical abstractions, but as representations of human activity – as practical knowledge. Alexander linked patterns to emotional fulfillment, rather than rational analysis or theoretical clarity. His search for patterns was informed by the hypothesis that there are archetypical forms and relationships that have established themselves as proven, enduring, and 'good' architecture. He looked for those structures that had over time taken the form of practical knowledge. Alexander never clearly defined 'pattern'. However, in *A Pattern Language*, he did describe 253 concrete patterns that are linked through language.[20] He saw these patterns as proposals that were picked up by others and adapted to new situations. For Alexander, to work with patterns was to take existing conditions seriously, whether they were the result of environment, city planning, societal or architectural constraints. He therefore argued for designing on-site rather than making an abstract blueprint.[21] He would go to a site and build a full-size prototype with poles and fabric.[22] For Alexander and for permaculturalists, planning is a hands-on, on-site process, and design is a kind of environmental analysis that is speculative because it develops patterns from existing situations and conditions. Patterns are thus the speculative result of imagination – in Alexander's work and in permaculture design.

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[18] Mollison, *Permaculture*, 44; see also Holmgren, *Permaculture. Principles and Pathways*, 247.
[19] Mollison, *Permaculture*, 102; Holmgren, *Permaculture. Principles and Pathways*, 127.
[20] Christopher Alexander, *A pattern language, Towns, Buildings, Construction* (New York: Oxford University Press, 1978).
[21] "[...] do not try to design on paper!" Alexander, *Pattern language* 267.
[22] In the "The Textility of Making," Tim Ingold also suggests that design and architecture should evolve not from abstract planning, but from the materiality of the site. Material thus gains active status in the process of design. Tim Ingold, "The textility of making," *Cambridge Journal of Economics* 34 (2010): 91.

Radical Imagination

The term speculative (from lat. *speculari* – to observe) is always connected to the visual production of knowledge. However, I am using speculation in a broader sense to mean a radical imagination as delineated by Hannah Arendt. In permaculture design, patterns are those 'images' that exist "beyond or between thought and sensibility".[23] They provide an avenue which "allows us to think the possibility of something beyond the epistemic demand of deciding the true and the false […]".[24]

The possibility of interrupting and altering the system of representation in which we decide the question of true and false involves the faculty of presentation or figuration, that is, the capacity to create forms or figures which are not already given in sensible experience or the order of concepts.[25]

And in fact, in past years cultural studies, media studies and the study of science have discovered design as a practice of knowledge. Some even speak of a 'design turn'.[26] The claim is that design, at the junction of science and art, utilizes practical knowledge of creation. The underlying theory is explicated by, for example, Joseph Vogl when he says that "every epistemological explanation […] is preceded by an aesthetic decision." Unlocking new areas of knowledge or insight is "always dependent upon the form of their staging."[27] Here, the production of knowledge is understood as a cultural and material practice constituted of medial technologies, aesthetic preferences, technical skills, and implicit, experiential knowledge.

This is the sense in which I propose understanding permaculture design as the creation of patterns or visual representations of practical knowledge, assembled from heterogeneous elements and built at and for a specific site for which certain scenarios seem plausible, meaningful, and productive. In this process, the environment is just as involved in generating knowledge as the designer or the plants. The milieu thus created itself decides whether linkages are interesting, surprising or practicable. Patterns are speculations, varieties of radical imagination that engender unexpected communities. The pattern of the spiral for

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[23] Hannah Arendt, "Die Einbildungskraft", in *Das Urteilen. Texte zu Kants Politischer Philosophie*, ed. Hannah Arendt (München, Zürich: Piper, 1998), 82.

[24] Ibid.

[25] Linda M. G. Zerilli, *Feminism and the Abyss of Freedom* (Chicago: University of Chicago Press, 2005), 59.

[26] Wolfgang Schäffner, "The Design Turn. Eine wissenschaftliche Revolution im Geiste der Gestaltung," in *Entwerfen – Wissen – Produzieren*, ed. Claudia Mareis et al. (Bielefeld: Transcript, 2010), 33–45.

[27] Joseph Vogl, introduction to *Poetologien des Wissens um 1800*, by Joseph Vogl (München: Wilhelm Fink Verlag, 1998), 13-4.

instance stands for cyclical processes and is found in permaculture design in, for example, herb spirals. Herb spirals combine our knowledge of light, shade, soil moisture, types of herbs, and insects in a very small space. They bring knowledge of what plants need to our attention and are therefore popular tools for teaching an other agriculture to children and youth with a very industrial ideas of where our food comes from.

Patterns are not strictly a form of knowledge, but rather forms of transferring, transforming and recontextualizing the way in which we see things. They change our thinking without any claim to truth. Isabelle Stengers, a philosopher, therefore characterizes the practice of environmental activists as situated because it aims at the "production of values, to the proposal of new modes of evaluation, new meanings".[28] "But those values, modes of evaluation and meanings." Stengers continues: "do not transcend the situation in question, they do not constitute its intelligible truth. They are about the production of new relations that are added to a situation already produced by a multiplicity of relations"[29]. In this sense, permaculture design is also an 'ecologic practice', but a practice that aims to *assemble*.

Material assembly and thinking organism

The manner in which the radical imagination of permaculture pattern analysis generates knowledge is not so by reading (from lat. *legere* – choose, select) or interpreting ('read' from Old English *r□dan* – to counsel, advise, consult, interpret) patterns, but rather through acts of assembly. 'Assembly' combines the Old French *assembler* – come together, join, unite, gather – with the Latin *assimulare* – to make like, liken, compare, copy, imitate, feign, pretend. Gilles Deleuze and Félix Guattari delineate 'assemblage' as a dynamic structuration of multifarious and nevertheless singular connections, conditions, objects, and practices that work both to recode and to decode.[30] These do not become concrete in a physical or discursive form, but rather refer to the interrelations of varying systems, technologies, processes, bodies, actions, and passions. Assemblages bring together symbolic systems and physical systems as well as expression and content. They cannot be subsumed under a greater order or assigned to a subject.

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[28] Isabella Stengers, *Cosmopolitics I*, trans. Robert Bononno (Minneapolis: University of Minnesota Press, 2010), 33.

[29] Ibid.

[30] Gilles Deleuze and Felix Guattari, *A Thousand Plateaus*, trans. Brian Massumi (Minneapolis: University of Minnesota Press, 1987), 71, 88-91, 323-37, 503-5; see also Manuel DeLanda, *A New Philosophy of Society: Assemblage Theory and Social Complexity* (London: Bloomsbury Publishing, 2006), 9.

Assemblages do however express the dependence of practices and artefacts on spatial settings. The nomad rides in the steppe and the man-horse is coded by this spatial ordering as smooth and then recoded as striated.[31] From this it necessarily follows that settings can change assemblages. In the case of permaculture patterning, we must therefore say not only that the pattern 'reads' knowledge from nature, but also that it itself is an assemblage that generates knowledge.

The generation of knowledge in permaculture patterning is thus not only discursively drawn from writing and language, but also from practices, technologies, collectives, the environment, etc. It is passionate, situational, contextual, and dynamic. The manner with which permaculture generates knowledge through structures could also be described with Nigel Thrift as "intelligencing":

> First, I take it that intelligence is not a property of an organism but of the organism and its environment. I want to move, therefore, beyond obvious organismal boundaries and towards the 'superorganismal' idea that organisms are integral with the world outside them as put forward by writers like Tansley and Whitehead (1920) in an earlier time.[32]

In this form of intelligencing —and this is the point I want to explore—the environment becomes an agent in a joint act of understanding and shaping the world.[33] Earth 'sends,' so to speak, its characteristics and in this way regulates the designer's behavior through the patterns thus created. Mollison speaks of "interactive processes" and the "resonance of things"[34]. Mollison and Holmgren see their role as permaculture designers as three-fold. Their actions are directed not at people, but rather at the earth.[35] Their design is not merely the result of human action and creativity and, third, it is a form of intelligencing—thinking between multiple human and non-human actors:

> We care for the environment and wildlife. In all our design work, we side with that 'super client,' Gaia, which is an old Greek word

[31] Idem, "1440 – The Smooth and the Striated", chapter 14 of *A Thousand Plateaus*.
[32] Nigel Thrift, "From born to made: technology, biology and space," *Royal Geographical Society* 30/4 (2005): 464.
[33] "The site itself tells you what happens there." Mollison, *Permaculture Design Course*, 72.
[34] Ibid., 10.
[35] "Though our immediate interest is the client, people are merely a temporary event on the site. Our real, underlying interest is the site itself, though we may not choose to tell everyone that." Ibid., 64.

> for the Mother Earth Goddess. Earth was conceived of then as a living, thinking organism, a biological entity.[36]

Gaia

In this quote, Mollison is referring to the Gaia hypothesis, which he understands as a way of moving away from the idea of 'Spaceship Earth' and towards an understanding of the environment that put the earth in the position of an intelligent agent.

> The Gaia hypothesis, as formulated by James Lovelock, is that the earth less and less appears to behave like a material assembly, and more and more appears to act as a thought process. Even in the inanimate world we are dealing with a life force, and our acts are of great effect. The reaction of the earth is to restore equilibrium and balance. If we maltreat, overload, deform, or deflect natural systems and processes, then we will get a reaction, and this reaction may have long-term consequences. Don't do anything unless you've thought out all its consequences and advantages.[37]

In Mollison's interpretation, Gaia is a "material assembly" that acts as a "thought process". This living mindset is focused on the conditions under which complex systems or organisms can develop. Living systems are said to be able to organize themselves. This is the starting point of the permaculture designer's efforts. She supports the earth's efforts to organize itself. Rather than trying to direct these processes, he builds on Gaia's self-regulating processes. This is in direct contradiction to Fuller's concept of Spaceship Earth:

> […] Spaceship Earth implies that we have the power and wisdom to manage the earth. The Gaia hypothesis of James Lovelock and Lynn Margulis has provided a brilliant example of whole-system science that makes it clear that the earth is a self-organized system.[38]

Mollison and Holmgren's understanding of the ecosystem as a "thinking organism" is a decided refusal of the concept of Spaceship Earth popularized by Richard Buckminster Fuller, an architect and philosopher, in his 1969 book *Operating Manual for Spaceship Earth*.[39] Fuller's theory can be seen as another

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[36] Ibid., 61.
[37] Mollison, *Permaculture*, 10f.
[38] Holmgren, *Permaculture. Principles and Pathways*, 3.
[39] Richard Buckminster Fuller, *Operating Manual For Spaceship Earth*, (Carbondale, IL: Southern Illinois University Press, 1969), accessed June 28, 2014, http://designsciencelab.com/resources/OperatingManual_BF.pdf.

transfiguration of the afterlife of systems theory. His regulatory second-order cybernetics concept was most successfully propagated by the American environmentalist Stewart Brant. Fuller and Brant understood the earth as a system (spaceship) that can be regulated, managed, and improved via technology. This approach, also known as the 'Californian ideology',[40] propagates an aerial, godlike view of the earth that turns the planet into an object of regulatory knowledge. Holmgren and Mollison are not interested in steering Spaceship Earth. Like Eugene Odum, they see a difference between a spaceship and the earth in that not all of the components and relationships of earth are known and understood, and not all systems are closed.[41]

The open und unforeseeable nature of the system is concurrent with its ability to self-organize, but also with its vulnerability: "In this understanding, ecosystems are self-regulating and self-organizing systems which are, however, instable due to their variable components (climate, soil, organisms) and thus [as Tansley says] 'extremely vulnerable'"[42] Eugene Odum had already proposed seeing ecosystems as a site at which the powers and energy of diverse agents and figures converged – be they animal, technical or inorganic— not just human spaceship pilots.[43] Earth as an ecosystem cannot be controlled from above. Mollison and Holmgren in contrast, in their elaboration upon the Gaia hypothesis, credit earth with a form of intelligence and with an active role in the design process. But what exactly does the Gaia hypothesis state?

The Gaia hypothesis was formulated in the 1960s by Lynn Margulis, a microbiologist, together with the chemist, biophysicist and medical doctor James Lovelock.[44] They proposed understanding the biosphere as a living creature, since

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[40] Richard Barbrook and Andy Cameron, "The Californian Ideology," *Mute* 3 (1995), accessed June 4, 2014, http://w7.ens-lyon.fr/amrieu/IMG/pdf/Californian_ideology_Mute_95-3.pdf.

[41] Benjamin Bühler, "Entgleitende Regulierungen. Zukunftsfiktionen der Politischen Ökologie," in *Selbstläufer/Leerläufer. Regelungen und ihr Imaginäres im 20. Jahrhundert*, ed. Stefan Rieger, Manfred Schneider (Zürich: Diaphanes, 2012), 186.

[42] Benjamin Bühler, "Zukunftsbezug und soziale Ordnung im Diskurs der politischen Ökologie," *Politische Ökologie. Zeitschrift für Kulturwissenschaft* 2 (2009): 40; Eugene P. Odum, *Ecology and Our Endangered Life-Support System* (Sinauer: Stanford, CT, 1989), 257. The Odum brothers' ecological tradition follows Arthur G. Tansley's ecosystem concept. The concept of ecosystems stresses dynamic balances within an ecological system made up of plants, animals and physical forces.

[43] Bühler therefore proposes studying the actor network theory to uncover its ecological roots. Bühler, "Entgleitende Regulierungen", 186.

[44] Lovelock and Hitchcock were able to prove that the atmosphere of Mars was in a state of chemical equilibrium. Earth's atmosphere in contrast is in a state of disequilibrium. The relative homeostasis of Earth's atmosphere is the result of intensive feedback loops which are kept in dynamic equilibrium at the earth's surface by biochemical processes (especially the production

the surface of earth is a dynamic, self-organizing system able to maintain equilibrium through various feedback mechanisms. The hypothesis is applied in the main to surface temperature, the chemical composition of the ocean, freshwater levels, and the composition of the atmosphere. It draws from a systems theory understanding of life and living organisms as open systems that react to their environment and regulate themselves according to their own needs as well as the needs of that environment.

As Lovelock wrote:

> The entire range of living matter on Earth from whales to viruses, and from oaks to algae, could be regarded as constituting a single living entity, capable of manipulating the Earth's atmosphere to suit its overall needs and endowed with faculties and powers beyond those of its constituent parts.[45]

Mollison and Holmgren embraced the Gaia hypothesis enthusiastically:

> The Gaia hypothesis of the earth as a self-regulating system, analogous to a living organism, makes the whole earth a suitable image to represent this principle. Scientific evidence of the Earth's remarkable homeostasis over hundreds of millions of years highlights the earth as the archetypical self-regulating whole system, which stimulated the evolution, and nurtures the continuity, of its constituent lifeforms and subsystems.[46]

At the same time, the concept of the earth propagated within permaculture design is full of contradictions, as Bruce Clarke has pointed out.[47] Lovelock remained firmly within the cybernetic discourse of control, because he understood the living system of Earth as possessing a tendency towards homeostasis regulated by negative feedback. Lynn Margulis however, building on Francisco Varela and Humberto Maturana's concept of autopoiesis, stressed processes of random, continuous, creation.[48] Margulis's Gaia does not aim to self-regulate, but is an "emergent property of interaction among organisms, the spherical planet on which

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of O2. This was one of the starting points of the Gaia hypothesis. James Lovelock, D.R. Hitchcock, "Detecting planetary life from Earth," *Science* (1967): 2-4.

[45] James Lovelock, *Gaia. A New Look at Life on Earth* (New York: Oxford University Press, 1979), 9.

[46] Holmgren, *Permaculture. Principles and Pathways*, 71.

[47] Bruce Clarke, "Neocybernetics of Gaia: The Emergence of Second-Order Gaia Theory," in *Gaia in Turmoil: Climate Change, Biodepletion, and Earth Ethics in an Age of Crisis*, ed. Eileen Crist, H. Bruce Rinker (Cambridge: MIT Press, 2009).

[48] Clarke, "Neocybernetics of Gaia", 295ff.

they reside, and an energy source, the sun"[49]. Holmgren in particular often points out opportunities to control systems through positive and negative feedback and transfers the cybernetic dispositif of control to the economy, to management techniques, and to government activity.[50] Mollison, on the other hand, stresses the uncertainty of feedback processes:

> Thus, stability in ecosystems or gardens is not the stability of a concrete pylon; it is the process of constant feedback and response that characterizes such endeavours as riding a bike. We are also in an area of uncertainty about the concept of end states or climax in systems - the state to which they tend to evolve. II is doubtful if any such state ever existed, as inexorable climatic change, fire, nutrient leaching, and Invasion deflect systems from their apparent endpoints.[51]

For Mollison, feedback and response is a continuous process. He doubts that it is possible to have total control, if only because the final horizon is not the survival of humanity, but of Gaia:

> All these effects are under some human control in a developed ecosystem. Protection from fire, positive nutrient supply to plants, and long-term evolutions are possible in terms of human occupancy. In the longer term, however, we too will be gone, and other species will arise to replace us (unless we take the earth with us, as megalomaniacs would do if we give them that chance: "If I can't take it with me, l'm not going…!") Just as it was the habit of kings to be buried with their riches, horses, and slaves, so modern warlords threaten to bury all humanity as they depart.[52]

Gaia will continue, whether with or without us. Bruno Latour emphasizes the lack of unity and sovereignty within the concept of Gaia:

> The great thing about Lovelock's Gaia is that it reacts, feels and might get rid of us, without being ontologically unified. It is not a superorganism endowed with any sort of unified agency. It is

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[49] Lynn Margulis, *Symbiotic Planet: A New Look at Evolution* (New York: Basic Books, 1999), 119.

[50] "This principle [apply self-regulation and accept feedback, K.R.] deals with self-regulatory aspects of permaculture design that limit or discourage inappropriate growth or behaviour. With better understanding of how positive and negative feedbacks work in nature, we can design systems that are more self-regulating, thus reducing the work involved in repeated and harsh corrective management." Holmgren, *Permaculture. Principles and Pathways*, 71.

[51] Mollison, *Permaculture*, 33.

[52] Ibid.

> actually this total lack of unity that makes Gaia politically interesting. She is not a sovereign power lording it over us.[53]

In any case, Mollison has created a model of nature that is not defined by culture as an antipode. Mollison's Gaia undermines the concept of the earth as passive, mechanical matter and humans as reasoning subjects by adding uncertainty, chance and the limits of human control into the mix—as well as the dynamics of the ecosystem as an intelligent system. At the same time, Mollison does not see Gaia as the primordial site of nature, but as a "thinking organism"[54], a "material assembly" that "appears to act as a thought process"[55]. Understanding nature as an assembly of material, intelligent processes turns 'nature' into a highly artificial entity of heterogeneous and relational actors and artifacts in a continuous process of creating itself (artifact, from lat. *arte*, by skill and *factum,* thing made).

Permaculture design was attracted to the Gaia hypothesis because it stresses the 'ecology' of knowledge. Here knowledge is not only found within nature, but nature itself is an actor in the generation of knowledge in the form of an assemblage. I believe this 'ecology of knowledge' is an important figure within the afterlife of systems theory. It replaces questions of controlling, regulating and steering systems – the concerns of first-order cybernetics – with questions of the materiality, embodiment, and visuality of dynamic processes of knowledge guided not solely by rationality, but by speculation in the form of radical imagination. The afterlife of systems theory in permaculture design therefore presents the history of science with significant challenges. How can we describe a history of knowledge that operates "beyond or between thought and sensibility"[56]? Particularly when this knowledge mingles discursive forms and visual patterns, it cannot be subsumed under a master theory or an ontology but takes the form of speculation and assemblage. When it is not guided by a sovereign power, but influenced by multiple actors. How can the afterlife of systems theory then be narrated?

The most logical answer would be to describe the creative practice of permaculture design – in the sense of a practical cultural technique of patterning – via practical transformations rather than via the texts and theories of its founders. This I have not done; nevertheless I do hope to have made a case for the recognition of the popular, practical knowledge of permaculture design. Systems

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[53] Bruno Latour, "Waiting for Gaia. Composing the common world through art and politics" (paper presented at the French Institute for the lauching of SPEAP in London, November 2011), accessed April 4, 2014, http://www.bruno-latour.fr/sites/default/files/124-GAIA-LONDON-SPEAP_0.pdf, 10.

[54] Mollison, *Permaculture Design Course*, 61.

[55] Mollison, *Permaculture*, 10.

[56] Arendt, "Die Einbildungskraft", 82.

theory lives on not only in the rationality of knowledge. The afterlife of systems theory in permaculture design expands our horizons to include a type of ecological thought that is based neither on cybernetics nor biology nor systems theory nor mathematics nor the like, but rather uses scraps of theory to generate a figurative and applied practical knowledge that is perhaps better described as non-knowledge.

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