Permaculture Assessment
Processes for Reliable Flourishing

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Abstract

Permaculture is an agroecological systemic design tradition for maximizing the sustained flourishing of resource-renewing cycles in which we participate. Despite success both as a design approach and design movement, improvements can address systemic challenges, such as providing design assessments that steer projects in directions more likely to thrive. Permaculture practitioners now recognize that project success does not stem primarily from technique choice or execution, but instead how those techniques engage their social context and resource networks. Quality in permaculture design now incorporates the quality of the design process itself. However, the idea of a comprehensive permaculture assessment misunderstands the multi-faceted character of the tradition, so we only approach assessing permaculture design processes.

We suggest that when one assesses a permaculture design process, one is assessing the reliability to lead practitioners in substantially improving the sustained flourishing of resource-renewing cycles. Yet, measuring this reliability is problematic, as design is a messy and chaotic enterprise that randomly rewards abductive insights. We instead develop questions that apply to the different aspects of many design processes, and then adapt those to permaculture, allowing assessments throughout the design process. We also compare permaculture design to other fields that have similar process structures, offering useful contrasts.

Introduction

In previous work, we described permaculture as an agroecological systemic design tradition aimed at maximizing the sustained flourishing of resource-renewing cycles in which we participate (Cassel, 2015). Permaculture is worth engaging both for contributions to systemic design and for areas of challenge that allow other systemic designers to engage as valuable co-participants. This engagement is particularly appropriate when developing systemic design approaches to social complexity. Social systems are within the scope of study for agroecology (Lovell, 2012), the science from which permaculture most directly draws from. Both agroecology and permaculture have manifestations as social movements (Wezel et al., 2009; Ferguson and Lovell, 2014). Permaculture practitioners have not been shy about social system design both as a permaculture tradition directly and through starting related organizations and movements (Mollison, 1988; Hopkins, 2008; Flores, 2006). Noted permaculture teachers are now aware of its capacity to address complex adaptive systems, such as cities, and are formulating permaculture's design elements to be directly applicable to problems of social organization (Hemenway, 2015a).

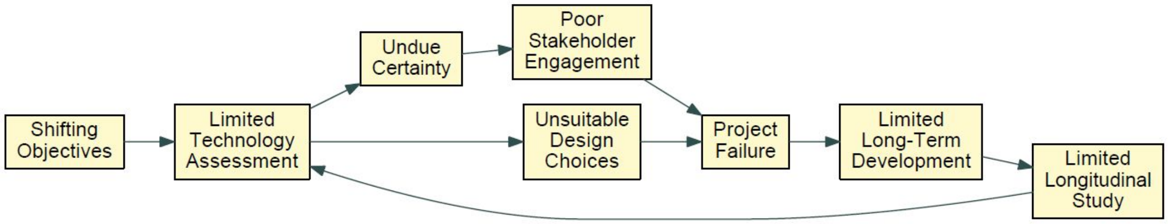

Figure 1: Permaculture's Systemic Challenges

Systemic challenges to permaculture (see Figure 1) disrupt establishing a positive feedback loop of longitudinal successes that establish diverse and regionally-appropriate logistical, knowledge, genetic, and financial resource bases. Our previous work provided methodological guidance to prevent shifting objectives. This work begins to address assessment practices, including technology assessment practices.

When facing the challenge of providing assessment, what permaculture practitioners have come to recognize is that the factors guiding project success are not only, or even primarily, what techniques were employed or that those techniques were executed correctly. Instead, the question is how should those techniques be pursued as part of the social fabric and similar systemic considerations: was any given subsystem configured with the appropriate consensus, at the appropriate rate of consuming resources, and staged appropriately with other similar subsystems? In this way, quality in permaculture design now incorporates the quality of the design process itself.

However, methods to assess the quality of permaculture design processes have proven so elusive that Toby Hemenway, a leading figure in North American permaculture education, asserts in correspondence a skepticism to any permaculture assessment as such (Hemenway, 2015b). This critique asserts that permaculture is a toolbox of approaches (organic farming, agroforestry, renewable energy, water harvesting, etc.) that are already proven in their respective domains. Furthermore, any particular use is a balance of food production, habitat provision, and input reduction that is impossible to assess against different goals. Even if one was comparing like goals, how does one get any power over the number of input variables? If one were to compare designs based on the same goals, whether using permaculture or another design approach such as holistic management, how could we measure the difference between the outcomes in any meaningful way? Overall, when one measures permaculture, what is one measuring? The critique ends by suggesting that Hemenway most values permaculture because it is the approach by which designed places feel most alive, suggesting a preference for grounding any final judgment phenomenologically.

The objective of this paper is to provide a constructive response to these questions and concerns. With this introduction, we can address each of these points in brief, raising the topics of both how to assess given permaculture design explorations and comparing permaculture design with other kinds of design process that share a similar structure.

An Initial Response

There is some truth in each of Hemenway's points, but to each of them there is also a constructive response which we hope improves permaculture.

When one is measuring permaculture, what is one measuring? It may be inappropriate to assess permaculture as a whole. Ferguson and Lovell (2014) has identified permaculture as simultaneously referring to a design system, a set of best practices from a variety of related domains, a social movement with many branches, and a complex of worldviews. Each of these aspects deserves completely different measurement approaches. For example, a movement might be assessed by how effectively it mobilizes people and how much ongoing participation there is at different levels of personal engagement. Rather than to assess permaculture, our goal is more modest: to understand the different ways to we might assess design processes that emerge from permaculture. It may be even turn out that one can design permaculture systems more effectively with other means than the design approaches usually associated with permaculture.

Permaculture is a toolbox of approaches (organic farming, agroforestry, renewable energy, water harvesting, etc.) that are already proven in their respective domains and needs no separate assessment. It is true that permaculture, as a design approach that relies on other scientific disciplines and technical practices, does not necessarily require independent scientific assessment given suitably rigorous development in the fields it is drawing from. However, other disciplines that draw from multiple disciplines still have strongly developed technical content of their own, particularly in the areas involving integrating and optimizing holistic solutions for subsystems with different constraints and local optima. For example, it is not the case that aerospace engineering, by virtue of being a toolbox of fluid dynamics, structural engineering, thermodynamics, control systems, human factors, electronics, finance and so forth, has no improvable technical content in itself. Instead, aerospace engineering pursues Multidisciplinary Design Optimization (MDO), a discipline for integrating subsystems together in an optimized way (MDO Technical Committee, 1991; Martins and Lambe, 2013), arbitrating contradictory goals and severe constraints in a principled manner. Though this difference is instructive, permaculture needs something different than "agroecosystem optimization." Permacuture must remain accessible and flexible, not strictly requiring either computational support or extensive technical training.

Any particular use is a balance of food production, habitat provision, and input reduction that is impossible to assess against different goals. It is true that different criteria lead to particular uses being incomparable, by virtue of one use being better by one weighting of potential criteria, and another use by a different weighting. However, saying that some uses are incomparable is much different than saying that no use can be compared against another use. There are two ways in which different uses may be comparable. First, more technically, it is true that some uses that are better than other uses along all reasonable criteria. We say if some system is better than all other systems by a particular weighting of criteria, it is Pareto optimal. There are uses that are not Pareto optimal, inferior along every design criteria.

Second, and more importantly, not all goals are equally well conceived. Starting with the goals means they may not be connected to any particular mission. What is to say that food production, habitat provision, and input reduction would even be on the radar without being developed from the context of natural systems design. Certainly many households were designed with no such goals in mind. Furthermore, even mission-centric goals may be poorly conceived if they are not attuned the sectors of the setting for the design. For example, given what your neighbors are doing and their attitude to change, it may be ecologically impossible to provide certain kinds of habitat provision from the confines of one's property.

If one were to pursue designing based on the same goals, whether using permaculture or another design approach such as holistic management, how would the outcomes be measurably different? Holistic management and permaculture use similar palettes of techniques as part of their best practices and, given the same goals, would likely come to similar outcomes. However, a comparison of given goals would truncate much of power of design processes, which discover and refine goals in interaction with potential solutions. In more open formulations that include discovering appropriate goals as part of the overall process, comparisons are difficult as different approaches generate different kinds of goals. However, we can say a design process is better if it effectively
generates goals capturing the underlying concerns it was deployed in response to, discovers all of the relevant factors and relationships, provides an analysis approach that reliable develops interventions to achieve those goals, and provides guidance in selecting between different design activities and interventions. Therefore, prior to attempting cross-approach comparisons, we should first figure out what constitutes effectiveness on the basis of the internal logic of permaculture's design processes. From there, it would be interesting to compare permaculture to design processes that are sufficiently general as to potentially find and implement the same goals, but come from a completely different background.

How does one get any power over the number of variables as to statistically say one design is better than another? As permaculture tends to arrange a large number of elements together in overlapping functions, it does present a combinatorial problem to know which factors definitely contributed to a given result. This is not made any easier by the influences of sectors, which may vary over time. The trick is to start building expectations for yield and keep score, to see if the performance of cycles developed analytically match those in practice.

Fortunately, when faced with many apparently viable designs with inexact data about interactions, we frequently don't have to choose. Permaculture often deals with layering a large number of different elements together. It is not only possible to have multiple elements for every function and elements that perform multiple functions, but to also vary these elements throughout a design and across sectors, creating arrangements that vary combinatorially and can be independently assessed. The logic of varying layout not only applies to agroecological choices such as planting arrangements, but also to social (varying the members used in teams between different projects)
and urban (choosing different patterns of businesses to be arranged together throughout a city) arrangements. By accounting for supplying functions multiple ways within the design, the maintenance requirements of truly viable designs should be low, allowing for more effort to be applied to establishing combinatorial systems than maintaining them, with the extreme case elevating neglect to the status of a development methodology (Shepard, 2013).

Phenomenological assessments, such as when a place is most alive, are the assessments that have the most real value. Many of use do not want our lives to be limited to responding to some quantitative systems of measurement. It is frighteningly easy it is to fall into shaping one's behavior to conform to numbers, from the amount of money one should be making to the number

of steps one should take in a given day. These quantitative proxies can indicate aspects of more intangible qualities such as usefulness to a community and appropriate engagement with one's body, but too often substitute for these qualities. Nonetheless, understanding the different ways one can make quantitative assessments can often create a deeper understanding, with attempts to make quantitative
models revealing qualitative aspects of the subject under study. As long as we understand that many forms of assessments are assessment of models built for developing our further understanding, and are not any kind of final judgment, assessment methods serve to enrich our experience.

Given these considerations, first we're going to look into how to assess permaculture's design processes. This will involve establishing what design processes consist of, establishing what kinds of qualities emerge from different aspects of their character, and what kinds of qualities they might have. Then, we'll use these lenses to examine permaculture's design process. Combining these two frameworks, we then should have an idea of what quality assessments emerge from permaculture. With this in hand, we can then assess permaculture itself by comparing the resources permaculture provides with other methods.

Assessing Permaculture's Design Processes

In previous work (Cassel, 2015), we suggested that there was a mission compatible with permaculture's ethics and methods: to maximize the sustained flourishing of the resource-renewing cycles in which we participate. This participation is necessary: by being human, there are certain intrinsic aspects of our being for which we can apply better or worse levels of care. This has been recognized in permaculture since Mollison (1988), which within the first few pages asserts that permaculture's core directive is to take personal responsibility for one's own existence and the existence of one's family, which given the later contents means that we actively participate in cultivating the resources we use, with an eye to creating permanent ongoing yields by developing ongoing cycles.

Flourishing is a standard which is appropriate for both materialistic and phenomenological assessment. Flourishing indicates excellence at whatever the object under consideration naturally does, including such attributes as health, growth appropriate to stage of development, robustness to reasonable environmental changes, and longevity of interacting life processes. Living systems that are flourishing are likely to retain their habitat and population. Each of these has some level of phenomenological assessment: one can think of themselves as flourishing to greater or lesser degree and this cannot be contradicted should that perception hold. However, others can also assess flourishing. That a place feels alive is a legitimate assessment of some degree of flourishing, though it is not as strong a phenomenological claim as providing complete mental and physical sustenance and engagement of the kind some natural farming practitioners claim (Fukuoka, 1978). The assessment of flourishing also has measurable physical properties, measurements over time and space of the properties described at the beginning of the paragraph. Both of these ways of knowing can hold the other in check, with perceptive observation finding a particular set of metrics wanting in their ability to capture reality, while measurement may indicate the limits or biases of current perception.

Given this it may be appropriate to measure the flourishing of a particular system, but how can we use flourishing as a standard for assessing a design process? Design approaches are effective when they reliably discover real and substantive concerns, and also workable interventions that are implemented to mitigate these concerns. Combining these ideas, we have a preliminary answer: when one assesses a permaculture design process, one is measuring the reliability of that process to lead practitioners to substantially improving the sustained flourishing of resource-renewing cycles that provide for the designer's human needs, or 'reliable flourishing' for short.

Of course, any assessment of how reliable a design process is should take into account the difficulty of the challenge it was meant to deal with. Therefore, we can't simply define success and then look to how frequently a given process was successful. We need more process-centric approaches to assessing design process quality, so we can handle the cases where it all went wrong despite doing everything right. This implies that we need to understand design processes and their quality in a general sense prior to seeing how permaculture design fits in.

Design Processes and Their Quality

How can we talk about the quality of a design process? We need to answer the question "the quality of what?" Let us start by establishing a very basic sketch of many design processes. The designer gets a sense that things could be different: this could be as explicit as a brief from a client or as vague as a sense of unease, or anything in between. Through activities, the designer comes to understand that there is (or is not) some challenge, and also either discovers that there are potential interventions that could be made or finds that the most appropriate response is not to intervene. With the changes between these situations, they begin to understand some of the impacts a given intervention could have on participants of the situation. They then also come to discover different kinds and configurations of interventions that could serve as a response to the challenge, as well as get a better feel for the challenge by discovering known and potential ways in which an intervention might go better or worse from any participant's perspective. If an intervention is brought about, we can assess its quality of both in light of the understanding of the challenge as we developed it and also from a holistic questioning of appropriateness.

We want to be clear that we are talking about design processes as comprehensive of the entire engagement, and not merely doing some kind of analysis to select between solutions. Successful designers switch fluidly between understanding aspects of the problem, researching the domain, developing solution concepts, developing solutions, introducing first principles, and other categories of activity (Cross, 2011). Often designers treat the initial brief not as a specification of a problem to be solved, but as a starting point for developing their understanding of a situation in which they have an opportunity to make an intervention (Cross, 2011). The real power of a designer
may come from the ability to strategically initiate or develop the correct proposal, rather than in their ability to react to one that is provided (Dorst, 2008). Consider a furniture system made for hospitals that identified the objectives of germ resistance, simple cleaning, caregiver ergonomics, bariatric patient support, and breathability (Sittris Company, 2009): the uncovering of these health-care specific priorities demonstrates that need discovery can be an important objective of high-quality design processes.

Given this sketch, let us pose a basic model of quality within the design process. This model has four key aspects: purpose quality, discovery strategy quality, evaluation strategy quality, and solution quality. To illustrate are some of the key questions to consider in addressing the quality of each:

- *Purpose assessment:* How well did we find a problem worth addressing? Was what was actually implemented really worthwhile by standards external to the logic of the problem?
- *Discovery strategy assessment:* At what rate did we continue to find of the different conditions imposed by the situation? Did the rate at which we discovered impacts diminish? Did we discover many solution approaches but find trouble discovering more? How well did we find modeling and assessment strategies? How well did we find discovery activities to approach the discovery problem?
- *Evaluation strategy assessment:* Of the considerations we discovered, how thoroughly did we use them in evaluating the intervention? How much of the “space” of different alternatives, and assessment conditions, did we cover? How accurate was each assessment?
- *Result assessment:* How good was the outcome given the kind of challenge it became? How did the outcome compare to similar interventions to similar problems?

In previous work (Cassel, 2014), we looked at the metrics of the Design Exploration Assessment Methodology (DEAM), an approach aimed specifically at assessing parametric engineering design (Clevenger et al., 2012; Clevenger and Haymaker, 2011, 2012). DEAM developed a rich body of discovery and solution assessment approaches, but did not take into account that discovering the problem is itself an important part of the engineering design process. This previous work extended it to include discovery strategy assessment with a non-parametric formulation (NDEAM). This work did not include purpose, as it is nearly impossible to conceive of purpose in the mindset of engineering design: if you have goals or constraints, go ahead and include them. Just as discovering all of the considerations of the problem was taken as a given from the perspective of DEAM, knowing when to keep a project going versus stopping or severely redirecting it was taken to be a given from the perspective of NDEAM. However, this is not true of all design processes: in particular risk governance and permaculture both offer some purpose-level guidance.

Another assessment provided by DEAM was challenge assessment, which assesses the difficulty of the corresponding problem was into consideration. This approach takes a different view of challenge: different situations are challenging in different ways. One way to understand the variety of difficulties is to understand how succeeding at each of the different modes of assessment might be made harder by the content of the problem.

- *Degree of purpose challenge:* Is the promise of potential impact important but only by virtue by speculatively pooling a large number of insignificant changes? Does the intervention clearly help by some criteria but seems harmful or wasteful by other criteria?
- *Degree of discovery challenge:* Were the important factors all up front, or did it take considerable effort to find them? When we decided to intervene, was it because we were confident we knew everything important or because discovering key factors was so expensive as to make some risk important? How easy was it to talk to different stakeholders? Does anyone seem to understand the subject at hand very well at all?

- *Degree of evaluation challenges:* How many different kinds of considerations are there? For each kind of consideration, how many are there? Do these different considerations of a problem couple together in complicated ways? How difficult is it to make each evaluation? Are we lucky to have found any feasible solution? Did clear differences present themselves or was the search space irregular in an analysis defeating way?
- *Degree of solution challenge:* What costs, in terms of resources, time, and money, did it take to design the solution? How much does the intervention cost to implement in these terms? How close is the margin between the value of the intervention as opposed to the costs to deliver it?

Let us now work backwards: given these different categories of quality, what do they assume or imply about the design processes they might be used to assess? We can see four aspects of design implied by each of these qualities.

- *Domain-specific Design Skills:* Design requires particular skillful activities, the content of undertaking the intervention itself, whether that be building, drawing, rearranging, or tending.
- *Synthesis, Analysis, and Selection Processes:* Through trial-and-error, modeling, prototyping, simulation, and other forms of evaluation, we discover the factors that lead to a particular intervention to be the one initially rolled out.
- *Discovery and Information Gathering:* We learn about all the factors that make up the situation, as well as all of the different factors relating to possible interventions.
- *Attending to Ethical Guidelines and Worldview:* We posit why a situation may need to change, and what kind of changes are a positive contribution.

This categorization allows us to imagine the design process as having the flavor of statistical stopping problems. Many of the more technical design disciplines allow evaluation by arrange their findings into particular elements related in understood ways. As we discover elements, we fit them into relational systems that allow us to interpret their consequences. However, these relations also give us facts about where we are in the discovery process. For example, suppose we are using a design system where stakeholders have concerns. We could ask “Have we done enough to discover the concerns of this stakeholder” and “Is what we know about this stakeholder typical or do we seem uninformed?”

It would be nice if each of these categories of assessment had clean and distinct ways to measure them, but that is a fantasy. Design is a messy and chaotic enterprise that randomly rewards the right series of insights made in fluid situations. Instead, we will tailor the above questions to permaculture to help provoke the right questions.

Permaculture’s Analytical Method

Prior to explaining permaculture’s analytical method, we need to introduce some vocabulary.

- *Element*: A member or item of a permaculture design. Permaculture always starts with some number of elements, canonically the designer and their family.
- *Need*: An input necessary for an element to flourish.
- *Function*: The effect by which an element meets a need for other elements.

- *Sector*: An outside factor imposing a certain level of energy or intervention. These include both climate considerations, such as temperature, sun angles, and extremes of precipitation, as well as social and governmental considerations, such as neighbor preferences and city ordinances.
- *Setting*: The context in which a design resides. The setting determines the sectors that are imposed on the design.
- *Work*: The amount of energy or excess effort each element needs to apply to keep the others functioning.
- *Waste*: Material outputs not able to be converted by the system to again serve the needs of elements

Permaculture design has a number of typical analytical design methods: highest use, needs-and-resources analysis, sector analysis, zone analysis, exploring random combinations, and building compatibility matrices between design elements. These processes can be assembled into a systematic procedure for arranging systems, described here in summary form (see Cassel (2015) for details). This analytical permaculture process (see Figure 2) uses cycles of open discovery to build processes with closed material cycles.

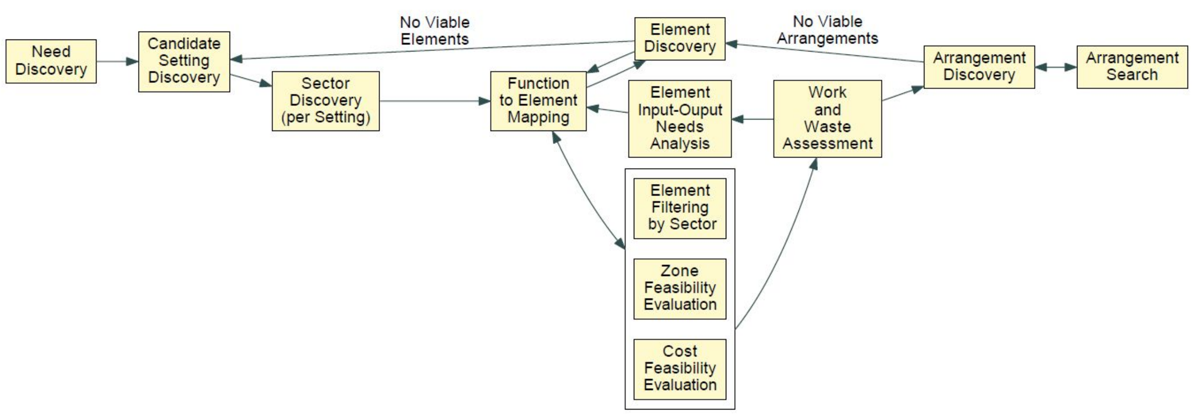

Figure 2: Permaculture's Analytical Method

Need Discovery Itemize an initial set of required functions using a wide range of ethnographic, generative, and literature review methods, as well as checklists of common needs.

Setting Discovery: Research various ecological, built, and social structures, places, and simulations that might be viable settings for an arrangement to meet the previously discovered needs.

Sector Discovery: For each potentially viable setting, we determine its sectors. Carefully consider all stakeholders, including natural stakeholders, at this phase.

With an initial set of needs, settings, and sectors discovered, we are prepared to begin the more analytical stage of this process.

Function to Element Mapping: For each function, select candidate elements or systems that can undertake processing, production, or maintenance to meet needs. To facilitate flexibly meeting multiple functions, prefer elements that leave the materials in the function suitable for other functions.

Element Discovery: For each function, research different ways it could be satisfied, consulting the literature, experts, and checklists, as well as undertaking generative exercises.

Sector, Zone, and Cost Feasibility: After finding a candidate set of elements, check if they are feasible. Elements can be disqualified if they don't belong to a desired sector, oversubscribe a given zone and thus are too much work, or are too costly.

Work and Waste Analysis: At this point, we want to detect external inputs, waste creation, and avoidable work, seeing if those needs should be accounted for.

Element Input/Output (I/O) Needs Analysis: If a candidate system has too many unmet needs, but still seems viable so far, we continue iteratively by finding elements that meet these unsatisfied needs. We find potential additional elements that satisfy the needs of the initial set. We try each of these in turn by order of apparent promise, observing the new set of needs added by the new elements.

Overall, the right way to think of the cycle of function mapping, feasibility evaluation, work/waste assessment, and element I/O needs analysis is as a non-parametric search tree of candidates. Each set of elements that could satisfy the initial needs is a starting point, but these elements may generate needs of their own, requiring a new set of elements to satisfy those needs, and so on until either the work and waste required is low enough or we run out of feasible elements to add. However, non-parametric search is not a parametric search within a known space of potential options, as made famous by Simon (1996) and found in many formulations of engineering design. Instead, the process motivates further discovery, as any potential need can motivate research for new elements, and any particular element can motivate research for potential needs and compatible teams.

The result of this cycle is a candidate set of elements for a given setting or property, each vetted to meet the initial needs and satisfy the existing sectors and designed to be part of a system of mutual relationships. We next want to see if they are logistically feasible. It is insufficient to have input/output relationships abstractly satisfied; they must be arranged and sequenced correctly in space and time. To do this, we start the assembly step, which itself has a discovery phase followed by a layout phase.

Arrangement Discovery: The purpose of the discovery phase is to be sure that we have a good number of potential arrangements in case a desirable arrangement is hard to find, establishing the combinatorial schemes for which we will search for desired arrangements.

Arrangement Search: Establish and assess layouts of element relationships over time using heuristics for increased efficiency, reduced travel time or required labor, waste reduction, and other criteria to order the search space effectively(Flores, 2006). The final arrangement will also be subject to being vetted by zones and sectors.

As it stands, this variant of permaculture design will let us propose metrics for discovery, evaluation strategy, and solution quality; as well as how hard each problem is by those standards.

For assessing purpose quality, permaculture design offers a directive and an ethical standard. The directive is to first be responsible for your own needs and the consequences of how they are met. The ethical standard is that permaculture designs will prioritize caring for the earth, then caring for people, and then conservation by minimizing consumption and population.

In order to allow the easier creation of assessment questions, let us think about the permaculture analysis process without its discovery elements. That process would be assembling a system dynamics model (Ford, 2010) with the following properties:

- specific constraints on levels that define us meeting particular commitments to produce inputs, process outputs, or maintain conditions,
- minimization of flows along particular paths corresponding to requiring external resources or wastes outside of what is normally part of the ecology (such as rainfall),
- and tolerance to reasonable variance from flows determined by sectors.

These immediately suggest the exploration criteria of having sufficient search to cover the potential space of arrangements, actively considering every part of the system, sufficiently exercising a variety of sector flows to obtain robustness.

However, before proceeding to permaculture assessment, let us now take the opportunity to think about how permaculture's system assembly process interacts with system dynamics. Permaculture has an advantage, which is by not trying to map out a system to figure out points of intervention, it never imagines it understands the system as a whole. Instead, it focuses on gathering as many interactions with the effect of the design as specifically and multi-categorically as it can. On the other hand, it still falls into another trap of system dynamics, which is that it may only model approximate, or even imagined, interactions instead of the actual dynamics of the system. A variety of outcomes are possible: the system might be coarsely right but improve with more detailed interactions, it might be completely wrong without detail but reward building that detail, or the cost of building up enough interactions to satisfy the system may be prohibitive to gather. Overall, the only assurance we have from analysis is "we have a system and it seems it might work".

Permaculture Assessment

With an understanding of the permaculture design process, we are now in a position to explain how each of the above qualities apply specifically to that process. Here are questions for getting at each of these different qualities from a permaculture perspective:

- *Result Quality:* Are the designers needs reliably satisfied (produced, maintained, processed) with additional yields? How little waste is generated? How few external resources are required? How much work is required?
- *Evaluation Strategy Quality:* Were all of the needs designed to? Were all of the selected elements evaluated against potential sectors? Did we consider a significant range of element combinations? Did we consider a significant diversity of arrangements?
- *Discovery Strategy Quality:* Has the rate of finding new elements, sectors, functions, and arrangements, decline as to become negligible? Were we ever surprised? At what rate? Did the design situation find cost/risk equilibrium?

- *Purpose Quality:* By virtue of the system, do we better take responsibility for the ecological presence of ourselves? Was the first purpose of the design to care for the earth, and then people? Did our design have a minimal footprint?

Just as there are specializations of the different qualities of the design process to permaculture, we can also specialize our assessment of the severity of different challenges.

- *Cost Severity:* What work, waste, and external inputs were required to configure this new arrangement? How much of those were incurred in the design process versus establishment?
- *Severity of Complexity:* How incompatible were elements with each other? How many elements were eliminated by sector, zone, or cost constraints? How many needs did the necessary elements introduce?
- *Severity of Obscurity:* Were relevant design elements easily discovered? Was the interaction between elements known? Were the needs readily forthcoming? Were design-eliminating sectors still being discovered surprisingly late?
- *Trade-off Severity:* Did the only viable ecologically sound designs produce a dramatically lower quality of human life? Did taking care of people mean that there were no further conserved resources?

Permaculture as a Design Process Among Peers

In this formulation, permaculture is a design process with a very particular structure. It can formulate the systems it constructs in terms of system dynamics, and synthesizes candidates in that analytical framework by means of its exploration process and ethical guidelines. We have previously looked at two other design processes, equally if not more general than permaculture that also can be interpreted as discovery processes and ethical guidelines surrounding a relational analytical core. These are optimum engineering design (Cassel, 2014; Clevenger et al., 2012; Clevenger and Haymaker, 2011) and risk governance (Cassel, 2011; Renn, 2008).

If you were to pick up a textbook on optimum engineering design (say (Arora, 2012) or (Papalambros and Wilde, 2000)), it will usually refer to the analytical framework used by engineering, and not the design process as a whole. On the positive side, these analytical approaches are very well developed, and their surrounding design practices are well-developed in a practical sense. However, the lack of discovery as part of the engineering design analysis framework means little assessment of the trade-off of the costs between continuing the discovery process versus the value of what might be discovered, and considers discovery an external process. This leads to forgoing investigating the quality of discovery in assessing design outcomes.

Risk governance, on the other hand, is strongly concerned with discovery and communication. Internally, its analytical framework is decision theory and game theory, asking how stakeholders are impacted by different actions, leading to interventions that articulate unexpected potential benefits and harms from their actions. The information discovery of risk governance is informed by this game theoretic framing, taking care in which kind of disclosures to make between different parties to best discover preferences and preserve intervention possibilities.

For each aspect of design quality, design approaches offer two kinds of guidance. One is known checklists and other forms of prior knowledge related to similar problems. The other is procedural knowledge that will help develop the necessary knowledge. Let us now look at each of these in turn.

Prior knowledge of quality solutions: When permaculture design is criticized, it is usually in this area. The community is still developing what combinations of elements will perform at specified competitive yields in a given condition. For example, if one were to ask to develop a permaculture farm with the specifications that it meets and the trade-off that it makes, practitioners may find it difficult. This is why agroecological studies with combinatorial designs are in progress. Engineering seems to have many of these sorted out, primarily by defining its boundaries based on what is known: engineering takes the principles found in science and applies them systematically to human needs. It does not promise the best, but the best from what is physically well-understood. When the transition from science to engineering is happening, risk governance is involved. Therefore, risk governance tends not to have a prior knowledge of solution quality: it is the approach for negotiating situations where we don't have this prior knowledge. In some ways, large-scale permaculture projects resemble the feasibility trials of risk governance.

Process guidance to develop quality solutions: Permaculture is excellent in providing practical techniques accessible to the layman as well as clear leaders working on the cutting edge. Materials aimed at grassroots participation will also emphasize their limits and point to disciplines of formal training that would be of value (Darwish, 2013). Engineering is similarly excellent, having great support for education in a variety of trades. Risk governance, as a discipline aimed at boundary issues where there may not be quality solutions, does a good job at developing expertise under those difficult circumstances.

Prior knowledge of candidate evaluations Permaculture is becoming progressively better at prior knowledge of candidate arrangements, identifying well-known teams of elements suitable for particular purposes and sectors. Engineering also does well in this regard by being able to evaluate many systems by simulation and more approximate calculations prior to a full design. Risk governance also effectively gathers prior knowledge about candidates through expert analysis and public deliberation.

Process guidance to evaluate candidates: The process of evaluating potential candidates is still very heuristic driven, making trial arrangements and seeing how things fit. Engineering, to contrast, has a very rich tradition of optimization and experimental design. The system-dynamics formulation of permaculture sketched above, in which found elements are arranged as to meet constraints and minimize other factors in a way robust to different conditions, is very much in line with an engineering design formulation. Risk governance already has this character, backed by game theoretic analysis lending itself to these operational methods.

However, despite being less sophisticated, the process guidance permaculture offers evaluation may actually be the most advanced, yet appropriate, form of guidance. It does not require an elaborate infrastructure of education, computation, and communication to support its work. Unlike many design processes which traverse between discovery, analysis, and deliberation, the analysis phase is also readily accessible.

Prior knowledge of elements to discover: One key contribution of permaculture to an accessible and appropriate agroecological design practice has been its system of categories. Permaculture not only finds, but provides knowledge about elements, niches, functions, and sectors, so that we know we need to find elements that fill those niches while providing those functions while tolerating or benefiting from those sectors, while providing the design methodologies that create the appropriate conditions for those interactions. These include not only classical agronomic constraints such as soil and climate (and how they can be improved with soil preparation, earthworks, and microclimates), but also social and legal constraints (and how they can be improved with organization and
political action). However, this combinatorial arrangement of elements is developed by responding to initial needs. Getting those needs right is vital to making viable ongoing projects. One key element missing from permaculture design right now is a detailed and specific listing of human physiological and social needs, as well as their intersection. How many vitamin C does a person who is 5’11”, 190 lbs, and is female need over the span of a week, and what are the consequences if they don’t get it? What kinds and level of contact with other people is appropriate for a person of a given personality, and what happens when they receive otherwise? What preparations will people of a given culture find appetizing and satisfying? As vital as considering the physiological scale of people in industrial design, it is equally as vital to include nutritional, interpersonal, and cultural needs in agroecological and social design. The ability of permaculture methods to build viable systems are hamstrung if their need finding processes are limited to questions such as “about how many apples do you think you would like to eat on any given week?”. The right model for this is Henry Dreyfuss’s pioneering work in physical measurement for improving human factors. Engineering has a strong tradition of already knowing what areas it will need to know, through this understanding of human factors and supporting checklists. Similarly, risk governance has a solid understanding of the kinds of risks that can befall human life, health, and property.

Process guidance for discovery: Although permaculture’s prior knowledge of what needs it must discover has a few holes, it is nearly made up for by a strong role in the design process for continually discovering new elements and interactions. Risk governance also considers discovery by means of attempting to engage a requisite variety of stakeholders, but intrinsically plays less attention in developing an integrated viewpoint. One potential reason for this is that permaculture continually engages system boundaries by designating included needs and functions versus the effects of sectors. To contrast, the formal practice of engineering design frequently does not consider itself to work on open problems, as discussed above.

Prior understanding of purpose: Permaculture design has started with a simple and clear set of ethics (earth care, people care, and future care/fair share), accompanied by basic principles (Mollison, 1988). In comparison, risk governance and engineering design have very limited prior knowledge of purpose, more constrained to what one does not do, rather than to what one does do. These prohibitions, the constraints of human rights and professionalism, say little about what appropriate systems are.

Process guidance for developing purpose: Permaculture also has guidance for developing the purpose. This guidance includes the requirement of long, holistic observation that discovers the needs that form a project and its boundaries (Flores, 2006). Risk governance also develops purpose by triggered by detection processes that warn of risks and rational communication that develops those observations into a community concern. Engineering processes seemingly have no method for developing a purpose, outsourcing this concern-raising to other design processes.

Overall, we see that permaculture is a purpose-design rich process focusing on appropriateness over technical completeness.

Conclusion

Assessing a permaculture design process is possible. When one assesses a permaculture design process, one is measuring the reliability of that process to lead practitioners to substantially improving the sustained flourishing of resource-renewing cycles that provide for the designer's human needs, or 'reliable flourishing' for short. This reliability can be observed in a particular process by the degree that it successfully produces worthwhile interventions developed through sufficient discovery and evaluation. Permaculture design compares positively with other system design processes, as it is comparatively purpose-rich and concerned with appropriateness, needing new attention only to a more richly informed understanding of people's physical and social needs.

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