A Pattern Language for the LIMITS Community

We Make the Road by Walking, A Messy Ethnography

Douglas Schuler
Evergreen State College
Public Sphere Project
Seattle, WA United States
douglas@publicsphereproject.org

Marloes de Valk
London South Bank University
London, England UK
devalkm@lsbu.ac.uk

Shreya Urvashi
Tata Institute of Social Sciences
Mumbai, India
shreyaurvashi@gmail.com

Scott Rose
Public Sphere Project
Vancouver, British Columbia, Canada
rose@publicsphereproject.org

ABSTRACT

This paper describes the process of two mutually informing activities: (1) the beginning of the creation of a LIMITS related pattern language, drawing from published material and feedback from the LIMITS community, and (2) the development of the Pattern Sphere (PS), a publicly available online system for supporting collaboration using pattern languages, which we believe can help support the work of the LIMITS community and other communities who are working to address wicked problems. Patterns and pattern languages present an approach to knowledge presentation in a semi-formalized way that has been used in many domains to help address complex wicked problems effectively. We intend for these patterns to make the knowledge of the LIMITS community more accessible. Moreover, we propose that these patterns could help people apply the core findings from the LIMITS work in real-life situations and, because patterns are intended to be used contextually, help them better understand where they are well-suited and where they are not. Patterns function only through application in, and adjustment to, local contexts, and this knowledge can spur their eventual integration into practices. Our hypothesis is that this work will be useful in at least four ways: (1) sharing the pattern and pattern language (PPL) perspective; (2) sharing useful patterns; (3) providing insights into the processes involved in developing patterns and pattern languages; and (4) providing a flexible, evolving platform for PPL work.

We're calling our research method a 'messy ethnography' because we wanted to place some attention on the choices we were faced with, the avenues taken or not, and the mistakes we didn't make, almost made, or did make as we went along. At the heart of this process was an online participatory assessment that we made available to the wider LIMITS community, taking stock of which of the 24 suggested patterns resonated most strongly while gathering general feedback as well as input on specific patterns. We will build on the assessments and comments to help craft the provisional set of patterns that we hope will provide a suitable foundation for future work. Future work will consist of a continuation of the development of both the Pattern Sphere software and the pattern language, in conversation with the LIMITS community and other communities who are helping to address the myriad wicked problems of the world today.

KEYWORDS

limits, pattern language, community, participatory design, sustainable design, sustainable computing

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1. INTRODUCTION

Over the past seven years, the LIMITS community (section 3) has gathered a body of knowledge around computing with respect towards ecological limits in general and climate- and climate justice-related limits in particular. The topics addressed range from design frameworks that can inform the creation of less damaging computing systems to analyses of existing design practices, detailed problem analyses, hypothetical and transitional systems and more. This paper describes the process of two mutually informing processes: (1) the beginning of the creation of a LIMITS related pattern language (section 2), drawing from published material and feedback from the LIMITS community, and (2) the development of the Pattern Sphere (PS), a publicly available online resource supporting the collaborative development and use of pattern languages.

We imagine these patterns to make the knowledge of the LIMITS community more accessible. Moreover, we propose it could help people apply the patterns from the knowledge base constructed through LIMITS in real-life situations to understand where they seem well-suited and where not, since patterns function only through application in, and adjustment to, local contexts and eventual adoption into practices. Our hypothesis is that this work will be useful in at least four ways: (1) helping to share the pattern and pattern language (PPL) perspective; (2)

sharing useful patterns; (3) providing insights into the processes involved in developing patterns and pattern languages; and (4) providing a flexible, evolving platform for PPL work.

We're calling our research method a 'messy ethnography' because we wanted to place some focus on the choices we were faced with, the avenues taken or not, and the mistakes we didn't make, almost made, or did make as we went along. At the heart of this process, was an online participatory assessment sent out to the wider LIMITS community, taking stock of which of the 24 suggested patterns resonated most, gathering general feedback, and input on specific patterns. We received very helpful responses from the wider community, including reflections on possible uses of the pattern language, suggestions for new patterns and thoughts on patterns we described in the survey. In parallel and informed by the feedback we received, we started drafting three patterns: Social and Environmental Linkages, Local Knowledge and Salvage Computing.

In section 2 we introduce the concept of pattern languages, what the relevance of one would be for the LIMITS community and how the Pattern Sphere could assist in its development and dissemination. In section 3 we discuss our methodology. We share our findings and reflections in section 4, to finish the paper with future work (section 5) and the three first draft patterns in the appendix.

2. PATTERN LANGUAGES

The concepts of patterns and pattern languages, in the sense we're using them, were introduced in the book *A Pattern Language* (APL), written by Christopher Alexander, Sara Ishikawa and Murray Silverstein, at the University of California at Berkeley in the 1970s [1]. Alexander passed away while this current pattern-based project was being developed. His work has been very influential in a variety of fields, especially in architecture and urban planning, but also to a very significant degree in computing and software development.

The APL book contains 253 patterns, each of which contains text, photographs, and diagrams. As defined by the APL authors, a *pattern* "describes a problem which occurs over and over again in our environment, and then describes the core of the solution to that problem, in such a way that you can use this solution a million times over, without ever doing it the same way twice." [1]. One pattern, for example, **Light on Two Sides of Every Room**, describes why this approach to room design is important and provides examples of how it has been used effectively. It does not dictate the specifics of exactly how the pattern should be used, as this will depend on other factors such as room purpose, shape, orientation to the sun, etc. which must be factored into the ultimate design.

A pattern language is a curated collection of patterns intended to be used together to address issues within some domain. The domain in APL is towns and buildings, basically the built environment, and **Light on Two Sides of Every Room** could be used together with the patterns **Interior Windows** and **Workspace Enclosure** to design a home office. Since its publication in the mid 1970s, the idea of a pattern language has inspired uses in a wide variety of other domains including the University of Oregon master plan, growing regions, costume design, community gardens, fire-fighting, creativity, group facilitation, wise democracy, mutual aid, and a great many tech-related pattern languages in fields such as HCI and user interface design. The domain of the Liberating Voices pattern language, which is used in this project and was coordinated by one of the authors on this paper, is community engagement and communication [31] and it was formulated within the context of a conference, the Directions and Implications of Advanced Computing (DIAC) symposia sponsored by Computer Professionals for Social Responsibility.

Typically, all the patterns in one pattern language use the same format, modeled to some degree after the structured format employed in APL, fields that include pattern title, a descriptive image, an ordered list of patterns (within the pattern language) that are used before the particular pattern is used, a problem statement, discussion (longest section), solution statement, diagram of relevant forces, and a list of patterns (within the pattern language) that are used after the particular pattern is used. While we reject the word "solution" in the definition above because of the misleading implication of finality and universality we believe that formulating patterns of perspective and action can be useful for groups who are attempting to address wicked problems, those problems, both timeless and timely, that defy formal, complete definitions as well as solutions [28, 33].

Patterns have several features that have been used to make claims for their usefulness in dealing with these types of problems:

- They are purposeful; they are intended to be used to address problems, to interrupt or divert the effects that probably would have happened in its absence;
- They are intended to be generative; they can inspire any number of products;
- They are intended to be fitted into individual contexts in ways that are appropriate for the circumstances.
- They are disciplinary-agnostic; they—at least potentially—can be used as a lingua franca, a common language that multiple communities of practice can take up to support coordination and collaboration between them;
- They are used systematically:
  - They acknowledge that more than one task or approach will be required to accomplish broad goals; and
  - They are intended to be used with other patterns.

The 'piecemeal', incremental, nature of their use as prescribed by Alexander et al, is intended to reflect the 'aliveness' of the process. It also captures the reality of addressing big problems that necessarily means addressing parts of the problem adaptively. Conceptually patterns and pattern languages exist somewhere between sweeping (grand) theories that purport to describe everything and specific recipes for doing one task, similar to the idea of the middle-range theory proposed by Merton [19, 33].

2.1 Why a Pattern Language for LIMITS?

The planet earth is afflicted with human-caused stresses that by many measures are getting worse. Computing has now assumed a dominant role in this transformation, both destructively and constructively. According to the description on the web site for the 2021, "The LIMITS workshop concerns the role of computing in human societies affected by real-world limits (ecological and otherwise). We seek to reshape the computing research agenda as topics that acknowledge a need for limits are seldom discussed in relation to contemporary computing research."

Computing, like most everything else, is subject to constraints of various types and styles, and assuming that limits somehow do not apply to it invites serious, if not dangerous, gaps in our understanding. But looking at the idea of limits more closely reveals that some of the constraints that we tend to accept can be misleading, only partially correct, or artificial [32, 5, 14]. Clearly in this sense, identifying which limits are actually limiting and which ones are not can be liberatory yet realistic at the same time. As we have seen from many of the LIMITS papers, this focus has led to a collective examination of the idea of limits from a wide variety of relevant perspectives including not only limits to economic growth, limits determined by physics, and limits to environmental resilience but limits to individual and group features and how to transcend them. Several papers have discussed the limits to these limits and why a focus on limits might be limiting [32, 22, 17].

We hypothesize that the LIMITS community is also a very good community for which a pattern language could be useful due to several features:

- significance of focus, a critical area, clearly a wicked problem—and one that is quickly growing worse;
- stated goals are to actually help make positive changes;
- evolving character of the pursuit, fewer disciplinary prerogatives;
- need for and intentional focus on interdisciplinarity and multi-sectoral cooperation;
- smallish size, a relatively new group and discipline;
- necessity of integrating research and practice;
- The multiplicity of perspectives and characteristics of "limits" within the community.

2.2 What would a LIMITS related pattern language look like?

At its core, a pattern language for the LIMITS community should contain a reasonable characterization of the insights and findings of the community as well as guidance as to how it can advance its goals. It is not a simple matter of 'mining' the existing papers. It should help capture the interplay of ideas without diluting them. It should capture the broad scope, from work that is focused on new technology to that which is focused on the social side. It should also be accessible. While the exact prioritization in which the tasks proposed by the LIMITS community should be undertaken has not been collectively established, the goal to have a meaningful, positive effect on the world has been.

The pattern language, like the LIMITS Community effort, is intended to be used. Just as the patterns from the APL book were meant to help design and construct buildings, the patterns that will arise from this work, even though they are likely to be more open than Alexander's, are meant to help design and construct digital infrastructures. As time goes on we hope and expect that there will be more focus on the physical artifacts while the more abstract ones still provide critical motivation and perspective. We are hoping that when this paper is first made available, the LIMITS community will find it interesting, even if very early in its development, and will be able to build on it in some way.

Our list of uses is quite general. Fundamentally, our intent (and hope) is that it will help further the research and action of the LIMITS community and to help foster communication and collaboration, both inside and outside of the community. Goals expressed in LIMITS papers are, among others, the need to change ways of thinking, build new ways of organizing, influence policy and share resources. Being useful to educators is also very important, a point that was emphasized via comments from the LIMITS community (and discussed below). Another major goal would obviously be using the patterns directly in the development of community-based, technological, or organizational, collaborative projects. But here a crucial reminder is necessary: The existence of patterns is by itself insufficient for people using them. Therefore, as a part of this work we are considering ways to encourage people to work with the patterns, including making them more public, more accessible, and more readily usable. The success of the project depends on participation over time and this participation, in turn, will help shape the development of the patterns, the pattern language, and the application, including how they are used and to what ends.

2.3 What is the Pattern Sphere?

In spite of all the interest in patterns and pattern languages, the sharing of patterns among the PPL community (in a broad and disparate sense) and the reuse of patterns is not widespread. To some degree the claims made by the PPL community seem to be under-substantiated. For one thing Alexander et al. suggested that people would modify or contextualize the patterns found in the book [1]. And although the patterns in APL never changed despite numerous reprintings, other people have developed pattern languages which incorporate somewhat modified APL patterns as well as new ones that they developed for the specific project they were working on. They also suggested that communities would form around the patterns. Regardless of the extent of these claims it seems like many of those avenues, such as federated hubs, provenance links, design for evolvability, communication around patterns, format diversity friendly software and more, have not been explored sufficiently.

For those reasons—and believing that available systems, such as Wikis or content management systems such as Drupal or Wordpress were not adequate for the whole range of processes that could benefit from a pattern orientation—authors Rose and Schuler started developing concepts three years ago for an ambitious pattern-oriented application that we are now calling

the Pattern Sphere (PS) (labs.publicsphereproject.org/ps). The basic idea is to develop an application that hosts patterns and supports the development, sharing, discussion, and use of patterns, by groups of people organizing and orienting projects. It will also support the creation of new pattern-based projects by groups with their own objectives, allowing them to control access as they see fit. A group, for example, may develop a set of patterns over the years working on them privately but releasing them periodically for public use, when they are deemed acceptable. Patterns could be shared —and conversations around the patterns could be had— by multiple communities. The intent is to support patterns in various formulations (because most pattern languages are similar but not identical to each other) and, something that came out of the discussions during the writing of this paper, to allow the patterns to be licensed as the authors see fit and host them, if they like, in another instance of PS under their control.

The PS is still a work in progress and will be for years to come. We are incorporating functionality that we need in the short term for small projects, while keeping in mind that we ultimately want it to be much more powerful, making sure to not program ourselves into a corner.

3. METHODOLOGY

We had several goals and this meant traveling down several roads at the same time: developing patterns while developing the Pattern Sphere allowed for each effort to inform the other. We're aware that this work has and may morph or meander and we're also aware of our own limited resources. Furthermore, since the issues faced by the LIMITS community are so complex and (seemingly) intractable, we knew early on that whatever we developed in the way of a pattern language would represent only a fraction of the overall project. We incorporated these inherent limits in this paper. We are tentatively calling this work a 'messy ethnography', for several reasons. Firstly, because ethnography is a particularly messy way of knowledge production; social reality is complex, dynamic and experienced in many different ways, the relationship of the researcher(s) to the research and its participants is equally complex and then there is the negotiating of the limits of a research site and the difficult task of how to narrate these encounters in a truthful way [23].

This brings us to the second reason for calling this a messy ethnography: we deliberately made space for messiness and uncertainty in the process of writing this paper, in order to navigate the complexity of the topic of this pattern language. We tried to 'make the road by walking', inspired by Paulo Freire and Myles Horton's process of 'talking a book'. Horton stated: "I see this thing as just unfolding as we go along" and he continues, and this was certainly true for us as well: "I think we'll run out of time before we run out of ideas" [10]. M. Six Silberman, in *Information systems for the age of consequences*, writes about the value of this approach when aiming at effective responses to global change, which requires transforming the global networked information-industrial society into a fundamentally different one. This, he argues, is a collective and uncertain endeavor: "one cannot fully map the road from here to there from here, as if from above; rather, the process is one of 'navigation', in which we discover the road as we walk it" [35]. While developing our plans, we did not fix much in advance, and 'talked this paper'. It was a slow process, which allowed us the time and freedom to reflect and act upon things as they were happening, and by doing this, we ended up with different but richer results than anticipated.

Something else changed while we were making the road: the final part of the patterns has always been called 'solution'. While discussing what a pattern can do and how it can be used, we confronted something that Horton tells Freire about in one of their conversations. He explains how someone once criticized his Highlander workshops by saying "All you do is sit there and tell stories". He compared this to someone criticizing a gardener in spring by saying that all they are doing is plant seeds in the mud, there are no plants, nothing is growing. Horton continues: "It was the seeds getting ready to start, and he thought that was the whole process" [10]. We moved from calling the end of the pattern 'solution', to 'summary' but finally decided on calling it a 'seed'. A pattern only comes to life after it is being applied in a specific context, in practice, and only then can it grow, be adjusted to that specific context and inspire change. There are no universal solutions, also not to problems occurring in many different contexts. Patterns are things to think with in order to grow situated ways of dealing with the problem space a pattern is part of. This metaphor of a seed adapting to other environments helps us conceptualize the pattern in a way that makes the core of the pattern more visible, making it more adaptable by other groups who wish to use it.

We are also taking the unusual approach of developing software to support the process at the same time we need it. Here we are also making the road (software) by walking: uncovering our needs while developing this project, identifying specifications for the software as we go. While this approach serves our current, specific needs to gather input on pattern candidates, to support pattern writing with various authoring approaches, and other partially determined and partially to-be-determined capabilities, the longer-range goal is to assist various communities who are working to address wicked problems.

3.1 Participatory Assessment

We know that we do not have the authoritative knowledge, skills, or the remit to do this without ongoing participation from the people within the community. The first activity along these lines was to acquire feedback from the community on a subset of the patterns for which we were considering further development via an online participatory assessment. What we are calling the community was everybody whose name was on a paper or presentation that was given at any of the LIMITS workshops and could be reached by email. We sent two notes to this list. When it became clear that we needed more replies we reached out to a few other people (5-10) who we believed shared the LIMITS perspective and elicited 3-5 assessments from them.

We hoped to elicit insights with the least overhead to the participants. To do so, we first cut down our long list of candidate patterns. Then, we divided the different kinds of

patterns we had in mind into subsections as Limits, Liberating Voices and Developers' Recommendations. Dividing the patterns into 3 different categories (via their origin) helped us be more inclusive. We included some patterns that we thought directly related to computing and the limits within computing, some that were part of the *Liberating Voices* patterns list but aligned well with the aims of LIMITS, and some that we as authors and as developers of the Pattern Sphere felt were important. We employed several criteria for choosing the patterns we did, including a diversity of pattern types, some whose themes seemed obviously applicable and some that seemed to be more on the margins. Another reason was to put to the test some of the assumptions of pattern advocates. The language was targeted at both novice and experienced pattern users. The entire set of pattern candidates included **Degrowth**, **Repair**, **Local Knowledge**, **Social and Environmental Linkages**, **Spiritually Grounded activism**, **Liberatory Technology**, **Permacomputing** and 17 more, for a total of 24. Our initial list of candidates was at least double that but we wanted to only present a manageable collection. The names of the 24 patterns and a short description were put on the PS site and participants could mark the pattern candidate as 'in' or 'out' based on how strongly they felt that it should be developed, formulated into a pattern (Fig. 1). The system automatically ranked them (Fig. 2.) according to how many in's, neutrals, and out's they received. Additionally, participants could add comments in relation to individual patterns and to the project as a whole. The system has stored this data, making it easy for people to revise their assessments at a later date and it also creates tables that make it easy to see how the collective assessments add up.

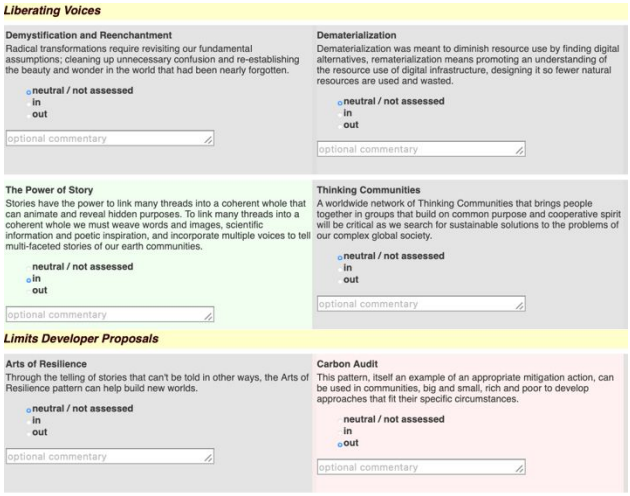

Fig. 1. Candidate Assessment Screen (portion) in Pattern Sphere (PS).

Pattern Title	Pattern Language	Votes (in/out)	Meter	Commentary
Social and Environmental Linkages	Limits Developer Proposals	17/0		1 comment
The Commons	Limits Within Computing	16/2		2 comments
Repair	Limits Within Computing	15/0		1 comment
Salvage Computing	Limits Developer Proposals	15/0		(none)
The Power of Story	Liberating Voices	15/0		3 comments
Degrowth	Limits Within Computing	15/0		1 comment
Local Knowledge	Limits Within Computing	15/0		1 comment
Enoughness	Limits Within Computing	15/1		1 comment
Limits	Limits Within Computing	15/1		2 comments
Sustainable Design	Liberating Voices	14/1		1 comment
Wholesome Design for Wicked Problems	Liberating Voices	14/2		5 comments
Environmental Impact Remediation	Liberating Voices	13/1		4 comments
Collapse Informatics	Limits Within Computing	13/1		3 comments
Liberatory Technology	Limits Developer Proposals	13/1		2 comments
Permacomputing	Limits Developer Proposals	13/2		3 comments
Demystification and Reenchantment	Liberating Voices	12/3		3 comments
Thinking Communities	Liberating Voices	11/1		2 comments
Arts of Resilience	Limits Developer Proposals	11/2		1 comment
Spiritually grounded activism	Limits Developer Proposals	11/3		3 comments
Appropriate Mitigation Actions	Limits Developer Proposals	9/0		(none)
Benign Computing	Limits Within Computing	9/2		3 comments
Carbon Audit	Limits Developer Proposals	8/6		3 comments
Dematerialization	Liberating Voices	7/3		5 comments
Citizens' Tribunal	Liberating Voices	6/3		1 comment

Fig 2. Assessment Ranking Table in Pattern Sphere (PS)

Since our approach involved participatory assessment within a 'messy ethnography' we had the twofold objective to include the LIMITS community in our project as well as to create the road while walking, in other words, creating new tools and methods that were appropriate and tangible as we reached new stages. This can be explained by looking at our approach to reach out to the LIMITS community for their feedback on pattern prototypes we had formed. We knew that to come up with various patterns that would be relevant to the community, we would need to take small steps. Once we had these sub-sections done, we still needed to decide on how to frame these patterns for the participatory assessment. We wanted honest and constructive responses from the community, along with maximum participation. This determined our coding and interface design as well as the content of the assessment we sent out. The initial responses were fewer than we had expected. Fortunately, the comments that accompanied the assessments turned out to be incredibly helpful. From reviewers recommending what patterns needed to not be included (via the "out" button) to suggesting ways to improve the patterns, there were also those who let us know where they could potentially see themselves using these patterns. The information from this step gave us much-needed insight into how to proceed. Based on the votes, we chose three patterns to develop further for the current paper. Those three patterns (in the appendix), are still drafts, individually written, each with their own approach. We aim to develop them further based on responses to this paper and project. The idea remains to develop a complete LIMITS related pattern language. While this is likely to contain many, if not all, of the 24 patterns we initially proposed, the language itself will evolve, taking into account the suggestions we received, while constantly making our pattern descriptions and developments going through the radar by receiving feedback on

them through various online and offline means like surveys, workshops and meetings.

4. FINDINGS AND REFLECTIONS

The feedback from the wider LIMITS community on our proposed patterns helped not only in getting a more holistic understanding of our own project, but also in modifying and redefining some of our patterns. The use of patterns to communicate knowledge and insight within computer/software systems design has changed throughout the years. Techniques and approaches for writing patterns and pattern languages are continually being improved. Since there is no single right way to write patterns, our approach to it also aims at a discourse on how to write patterns effectively.

Of the proposed 24 patterns, **Social and Environmental Linkages** received an overwhelming yes with no respondent voting it out. Thus we decided to develop this candidate into a full-fledged pattern (see Appendix). Other candidates which were well-received by our respondents include **Salvage Computing**, **Degrowth**, **Repair** and **Local Knowledge**. We chose two of these to develop further. **The Commons** as a pattern formed an interesting case; it got the maximum number of upvotes, yet also received 2 downvotes; mostly because the short description of the pattern needed to be more inclusive and specific. Reading the comments helped us see relationships between various patterns that we had not seen previously. Generally speaking, this is an inevitable and positive outgrowth of the pattern language approach: the patterns are *intended* to be used with each other. Ignoring the case of duplication or total subsumption of one pattern concept by another, the pattern language developers must learn how to deal with these potentially 'overlapping' patterns. For instance, **The Commons** had components of **Local Knowledge**, and **Enoughness** could be looked at through the lens of **Degrowth**. This led to the next (and present) stage of our pattern writing, where we analyzed the votes, absorbed the comments and spent some time reworking the patterns. We are in the process of renaming, redefining and reformulating some, while merging others. This incidentally will help with the design of PS, since patterns are intended to be manipulated in these ways, but the computer support for this does not exist.

Several people commented that **Carbon Audit** was inadequate because it oversimplified the problem; carbon is not the only pollutant that is leading to climate change. Clearly some broader meta-pattern involving auditing, such as **Environmental Impact Auditing** was needed and **Carbon Audit** could then be an example in that pattern, or even a pattern under that. On the other hand, Daniel Pargman's work on carbon audits in relation to work-related travel at his university, inspired the idea of the **Carbon Audit** pattern, which might be very useful to computer researchers and academics who travel more often than the regular person. The pattern might also be reconceptualized as an element of **Transparency**, which may overlap with **Citizens Tribunal**. It is up to the developers and users of the language, which level of detail and distinction is needed. Ultimately, this entire exercise showed us that since none of our patterns had more out votes than in votes, no pattern candidate needed to be rejected at this point.

Some of the comments suggested different interpretations or critical perspectives that would help with future work. For instance, in the verbiage of the **Power of Story** candidate, someone pointed out that it could be put in more explicitly that stories could be employed for both good and bad. Also, in some instances, patterns that weren't placed on the assessment, **Transparency**, for example, one of the patterns in the LV system, seemed useful in the discussion about the **Carbon Audit**.

A strong use case for this pattern language turned out to be education. Several participants in the assessment pointed to this potential. First, someone suggested using the pattern catalogue as a starting point for students wanting to research along the lines of LIMITS, as a collection of ideas to engage with, finding out which ones resonate most with them. Someone raised the question of how an inner (and thus also outer) transformation can be sustainably advanced individually and collectively? They pointed out that most, if not all, patterns require a mindshift in society and ultimately in every individual, which they do not see at the moment —despite all the crises, risks and dangers. They mention that understanding and acknowledging something rationally does not constitute an inner transformation. This observation is important and, in fact, could serve as inspiration for a new pattern, one that could integrate several viewpoints that run through the LIMITS papers (Sam Mann's "Sustainability Lens" certainly is intended to accomplish something like **Mindshift**). Perhaps it could also be partly addressed through the practice-led application of patterns, something proposed by Marvin Landwehr; learning by doing and prioritizing making a real difference. The use of LIMITS related patterns within practice-led research could help this transformation and address another point that was raised; the discussion and application of these patterns by non-experts. Students in different fields, from art and design, to computer science and engineering, could use the patterns to start conversations, brainstorm project ideas, interrogate projects from different angles and hopefully transform, fork and develop the language further.

Admittedly, the current stage of our pattern development for the LIMITS community makes it somewhat premature to come up with a set of evaluations and validations. However, true to our approach of 'messy ethnography' we intend to continue the pattern work: evaluating, improving, and validating the patterns we've started and other promising candidates. The participatory assessment resulted in two major realizations for us: even though the number of respondents we had were less than we expected, the quality of responses and the thoughts put into the comments more than compensated this. Thus, our aim now is to include more people in the assessment (and, indeed, all aspects of the process) while maintaining, if not improving, the quality of assessments we have. A substantial number of our patterns resonated with the larger community. Some feedback on realigning our lens and/or approach has only helped us move further along with this project. Further evaluations will also include which kind of patterns (prescriptive or solution-oriented)

are more effective for which problems. While a prescriptive pattern language describes the steps or recipes for solving the problem, a solution-oriented pattern language describes the desired seed, or as is found in some works, the expected result.

Circumstances dictated that we could not 'complete' a pattern language in the time frame allotted. But what to do about the work that didn't get done? e.g. the patterns that were suggested by members of the community, including **Technological Sovereignty of Local Groups** (Landswehr) and **Positive Mindset** (Mann). How might a group present work that has begun but is not finished? The approach that we are developing within PS is the concept of workspaces that are owned by the group that contain patterns and related information. One set of workspaces might contain patterns that have been (1) proposed but not assessed, (2) assessed but not developed yet, (3) recommended (assessed) and under development, (4) released for specific communities, and (5) released for the world. As part of laying out work for going forward, the 100 or so ideas that seem worthy of consideration as patterns that can be found in the LIMITS papers could be entered into the first stage of the workspace, in addition to the ones suggested above and the ones from the initial list, from which the 24 patterns that went into the online assessment were drawn.

4.1 Links between LPL and PS

How can the LIMITS related pattern language inform the development of the Pattern Sphere? During the writing of this paper, a few patterns seemed to be particularly interesting to apply during the development of the PS. **The Commons**, one of the Liberating Voices patterns, and one that received very high marks in the PS rankings seems particularly relevant. One lesson from the pattern is that Commons are managed; they have "specific rules and social norms … that can help us protect and manage our common assets" which presents the possibility that the LIMITS community itself should manage not just the patterns it produces but the entire project on the site. Thinking more broadly, it also suggests that any federation of PS sites, could be governed by its members, each "member" being a node on a network of PS instances, as well. It also has implications for how the code is licensed. One implication in terms of helping to create a freely available resource is that it should be licensed using an open source license which allows for copying, modification and redistribution of the code (and, possibly, the patterns they develop) except for commercial purposes [4]. In practice, this would require well documented code that facilitates this sharing and reuse by others. Another pattern that can be applied is **Salvage Computing**, by making sure the PS can be accessed on older devices and is usable for people with intermittent Internet connectivity. This means keeping the web design simple and lightweight, requiring little client-side computation and by for instance making it possible to download an offline version of a pattern language [29]. **Local knowledge** and **Participatory Design** could inform the design of a system that allows for self-hosting, meaning a community can run a local version of the PS on their own server, with their own dedicated pattern languages stemming from their local context, linking back to the feminist principle of situated knowledges [12]. We have discussed the possibility of a federated PS, in which local instances could choose to exchange patterns with other instances.

One of the current design goals is facilitating the transfer of patterns to and from PS depending on the nature of the license. The assessment capabilities in PS were added in order to support this work. As work continues on this pattern language, we will continue to build out the PS to accommodate the needs that arise for that. At the same time, we plan to incorporate patterns and pattern languages from other relevant domains, with the hope of encouraging the cross-fertilization that will be vital if we are truly going to make any progress on the wicked problems before us.

5. FUTURE WORK

We presented ourselves with the challenge of how to conduct a focused, but messy, project to make tangible progress towards developing a pattern language for the LIMITS community. Because we knew that we could not complete a pattern language in such a short period, we developed a plan to take meaningful steps along the way to a complete product. It also meant designing an online system, the Pattern Sphere, to keep track of partially completed work, that would continue to host patterns and promote assessments and conversations about the patterns.

To this end we have identified dozens of patterns that we suspect are appropriate to the LIMITS community, had some of the candidates assessed by the community, created early approximations of three new patterns (**Salvage Computing**, **Social and Environmental Linkages**, and **Local Knowledge**), and worked together to develop design ideas and operational code to support these activities.

Future work in developing the pattern language will consist of a continuation of the development of both the Pattern Sphere software and the pattern language, in conversation with the community and beyond. By pushing through with this project and moving to next steps, we will continue to inform the design of the PS, particularly the evolution of patterns, from identifying candidates to formulating complete patterns. We also plan to convene workshops that move this forward in various ways, such as using the patterns in the classroom for brainstorming and designing. Our hope is that the patterns will be used for discussion and debate but also for the development of actual collaborations and projects.

The LIMITS Community is hoping to help address the wicked problem of computing within limits. Ironically that problem is seemingly limitless; it is ubiquitous and takes different forms in different contexts. We (and others) believe that patterns that represent useful abstractions that can be adapted to local circumstances can help represent and leverage the collective knowledge and wisdom that will be needed to address Computing within Limits issues.

The focus on limits for the workshop series planted the seed for a very rich set of explorations. Over a short period of time the LIMITS community has brought together a rich trove of

ideas and interrogations: from our non-exhaustive reading of the LIMITS papers it seems that over 100 ideas could be formulated as patterns. Our hope is that in some way this pattern-based approach can help capture some of this intellectual and compassionate richness of the community and move that forward, both within the community and beyond. Naturally we hope that the community will find this work interesting and useful and will work with us to improve the areas where it is lacking.

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APPENDIX

Salvage Computing

Pattern introduction

This pattern links repair practices with the potential of planned longevity and working with waste as a resource [38]. There are many papers in the history of LIMITS dealing with this topic, leading to a very rich pattern.

Links

Right to Repair, The Commons, Open Source Ecology, Local Knowledge, Degrowth, Enoughness, Permacomputing, Environmental Impact Mediation.

Fig. 3. Detail of the iFixit Repair Manifesto, by iFixit.

Problem

Information and Communication Technology requires immense amounts of resources; metals, rare earth minerals, water, silicon and plastics as well as fossil fuels for their extraction, transport, production, use and disposal. The production and disposal of ICT hardware takes place, for the largest part, in countries with little environmental, health and safety regulations, polluting bodies, water, air and soils, for the largest part in the Global South. The resource use associated with ICTs is going to grow, since it is a rapidly growing industry that is currently selling the hardware and services required for the so-called 4th industrial revolution, encompassing the Internet of Things —including anything from industrial applications to smart fridges, from smart cities to self-driving cars—AR, VR, mobile media and games and their accompanying 5G telecommunication network and data centers closer to the edge of networks.

This growth happens in a rapid upgrade-or-die cycle. Planned obsolescence is implemented in hardware as well as software. Hardware is not made to last, and often contains components that will break relatively fast, even though for instance microchips, can last for decades. Because the hardware is often made in an unrepairable way—meaning if it breaks, it can only be replaced entirely, even if only one small component is broken—because it is cheaper to produce and it forces people to buy the product again relatively fast. Next to that, software and firmware for devices are not maintained after a certain time, so that even if the hardware still functions, the device becomes unusable because of faltering or insecure software. Lastly, software and services are increasingly demanding, needing faster CPU's, GPU's and for instance higher resolution screens, forcing hardware upgrades as well. The salvage computing pattern tries to address this problem of wastefulness and pollution that is happening on an industrial scale, by locally working with what is already there.

Context

Salvage computing means making use of locally available discarded hardware, transforming it into a renewed resource. It involves hardware repair and maintenance, the development and maintenance of open source software for older devices for which manufacturers have stopped their software support, hardware sharing, and lobbying policy makers to create regulation and legislation that enable these practices.

Reasons for using this pattern can be an environmental ethics incompatible with the wasteful practices of the technology industry. Microprocessors for instance, can last for decades, and should be considered a precious resource based on the embodied energy they represent. Chip manufacturing, as opposed to hardware use and energy consumption, accounts for most of the carbon output attributable to hardware systems [9]. Another reason to turn to salvage computing could be economic, as buying new hardware is expensive and not affordable for many. Which leads to the third reason: inclusivity. Keeping up with the latest developments in hardware and software is not affordable for most, globally, and therefore excludes the disadvantaged from participation in using digital services and software that require recently produced hardware. This exclusion puts the already marginalized at a further socio-economic disadvantage, and reinforces the digital divide. There are other social justice related reasons, especially solidarity with workers in production facilities and formal as well as informal e-waste processing, who are exposed to toxic materials, hazardous working conditions and are poorly remunerated. Next to that, the environmental harm in the form of pollution, water and energy use, further endangers the health and well-being of workers and citizens living in proximity of factories, microchip fabrication plants and mining facilities.

There are many stakeholders involved in this pattern: citizens, software developers, engineers, policy makers, lobbyists, repairshop owners and workers, repair cafe organizers and visitors, educators, hardware producers,, factory workers, miners and workers in informal and industrial e-waste processing facilities.

Discussion

Salvage computing has been described in several LIMITS papers in the past and together they provide insight into the

applications, obstacles and potentials of this pattern. Barath Raghavan and Justin Ma discussed future scenarios involving resource and energy scarcity and point to reuse of hardware and software in computer networks as a way to avoid the construction of too many new devices with high embodied energy costs. They argue for networking technology to follow the principles of Appropriate Technology, including making devices simple, composed of local materials and easy to repair [26]. As Barath Raghavan and Shaddi Hasan point out in their paper *Macroscopically Sustainable Networking: On Internet Quines*, a salvage Internet is one way to drastically decrease the Internet's dependencies, removing the need for manufacturing and transportation, as it uses only common, locally available components. They acknowledge it cannot be sustained in the long-term because it relies on functioning, or at least repairable, hardware [25].

In *Towards a World of Fixers*, Josh Lepawsky addresses this problem and identifies barriers and enablers to third party repair in the contexts of design, manufacturing, policy, and practice. One of the barriers Lepawsky mentions is planned obsolescense —the design for reduced service life. Ways manufacturers achieve this is through making the replacement, repair or upgrade of components difficult or impossible. An example is the loss of user-detachable batteries, and using adhesives or soldering components to boards instead of using screws and bolts, and if screws and bolts are used, using proprietary ones. Next to that he mentions the use of restricting end-user license agreements and the criminalization of third-party repair. Roura et al. analyse the eReuse project in Barcelona and identify the association of reuse with poverty as an obstacle, as well as bookkeeping practices that devalue devices faster than their actual lifespan, creating the idea of valueless items that will trigger them to purchase new devices instead [24].

Enabling factors Lepawsky identifies are legislation and regulation requiring manufacturers to make devices repairable, with as a first step advocacy for right-to-repair legislation. Only after these changes in design, manufacturing, and inherently the business models of hardware producers, have materialized, can there be a thriving network of independent, DIY maintenance and repair practitioners [13]. Brian Sutherland mentions the importance of enforcing manufacturers to use universal components, connection standards and interchangeable parts such as USB to ensure current and future compatibility between devices [37]. If repairing is not an option, reusing a device in a different way than its intended purpose, is another path, as pointed out by Remy and Huang. They also mention the enabling of a shift in lifestyle choices, one from wanting to possess the latest gadget to one in which it is desirable to own a device for a long time [27]. Blevis et al. call this New Luxury, where products are considered luxurious because they are of high quality and standard, not because they are expensive [3]. Heirloom computing is a related term, that expresses the desire for long lasting computing hardware that could be passed down from generation to generation [16].

Enabling factors on the software-side are discussed by for instance Devine Lu Linvega, one of the voices of the solarpunk merveilles.town Mastodon instance. They propose that creating software targeting old hardware might be a better approach than a focus on low-power, single-purpose computers, that may have lower energy consumption during their lifetime, but do require manufacturing [15]. Gemini protocol creator Solderpunk thinks along similar lines when writing: "the real long-term future of computing consists of figuring out how to make the best possible use we can out of the literal millions of devices which already exist". He argues that operating systems that still run on older hardware, and the software running on those operating systems, are very valuable things to develop and to maintain. He lists several things developers and users can do as 'good solarpunk praxis', with at the very top not buying any new devices, and instead investing in user-servicable used ones. He advises developers to invest in an (at least) 10 year old device and test their software on it, to push back against software 'progress' deprecating still functioning hardware. He also advises to support projects which develop software running on older or unsupported hardware, and those trying to 'jailbreak' locked down devices to make them more general purpose; by donating hardware, writing code, writing documentation or donating money [36].

Enabling factors in the DIY field of repair are skillsharing, documentation of repairs and the sharing of that documentation. In their paper *Unplanned Obsolescence: Hardware and Software After Collapse*, Jang et al. emphasize the need for social networks and institutions of people interested in computer repair, as they might prove invaluable for sourcing parts and maintaining the skills needed for successful repair culture [11]. There are currently several online communities involved in documenting repairs to consumer electronics, including computers and smartphones; the most prominent example is iFixit, a website with over 80,000 documented repairs (Fig. 3). The website also sells commonly needed materials, tools and spare parts. The Restart Project, a UK based organisation that started in 2013, is organising repair events across the UK and internationally. The project also lobbies for the Right to Repair in the UK and Europe. Lastly, in the Netherlands, many city councils have started repair cafés that welcome citizens to bring their broken devices in for repair in community centers. The Repair Café initiative was started in 2009 by journalist and activist Martine Postma in Amsterdam. Today, there are about 2000 cafés worldwide. Next to these grassroots initiatives, there is also a lively commercial smartphone repair culture consisting of small shops, also extending into hacklabs and fablabs, with an associated ecosystem of sourcing spare parts and skill sharing; unauthorized, sometimes very creative and often illegal interventions [20].

Scholar Jennifer Gabrys describes salvage as a practice of engaging with the discarded "with an eye to transforming what is exhausted and wasted into renewed resources" [8]. She adds the important observation that this process also means engaging with the conditions that led to disrepair; planned obsolescence, the rapid upgrade-or-die cycle of the tech industry and consumer capitalism in general, not to mention the impact of this on the Global South, which is receiving the West's e-waste and suffers

the pollution caused by the production of the Global North's technology. The Right to Repair campaign engages with one of these conditions: planned obsolescence. The campaign was started in 2019, with as long term goal to remove the barriers to repair products, and in the short term ensure the EU introduces a scoring system on repairability as part of the existing energy label for all energy-consuming products. The campaign gathers 40 organizations from more than 16 European countries. Thanks to the successes of the Right to Repair movement in Europe, repair practices are gaining momentum there.

Out of precarity, and because of the ongoing impact of colonialism, there are very rich and creative repair practices in existence—Jugaad, Gambiarra, Resolver, Shanzhai. Because of the sudden attention in the West to e-waste and supply chains, these practices of improvisation are appropriated and fetishized, yet as Ginger Nolan argues, the romanticizing of the inventiveness of these practices can function as an excuse to keep economic instability and precarity in place [21]. Instead, a focus on reviving historical, local repair practices that have become scarce or have disappeared could be a way to revive not only more sustainable practices using locally sourced material, but also reviving the skills that cannot be transmitted digitally, as well as traditional forms of negotiating value through the process of fixing, also things that cannot be quantified, such as the social role of repairers within a community [18].

Considering today's urgent need to shrink consumption of resources, it is surprising to see that from the list—reduce, reuse, repair and recycle—the last one is the most wasteful, yet has gotten most attention. This emphasis on recycling can only be explained because the other three point to economic degrowth, an unpopular topic in mainstream politics to date. This shows the importance of a political agenda, next to design and praxis.

Seed

The salvage computing pattern can be practiced at multiple scales. The largest scale is the one of developing and supporting a political agenda focused on degrowth and alternative economic models. One scale smaller, there is the demand for new laws requiring producers of electronic devices to make their products last long (planned longevity), repairable, with among other things: modular design, production of replacement parts for models for a substantial time after the release of a product, software and firmware updates and the eventual release of those as open source software, allowing others to take over after support is no longer required by law. Yet one scale smaller, there is the support and growth of local repair economies, both commercial ones as well as grassroots and activist projects, from repair-shops to repair-cafes. This support could include the legalizing of repair activities on proprietary hardware, as well as financial support for community projects. At the scale of software development, a focus on open source software and operating system development for older devices would support this pattern. Locally as well as online, the construction of a knowledge commons on how to do repair and hands-on skill sharing can help individuals and communities looking to engage with this pattern.

Social and Environmental Linkages

Pattern Introduction

The Social and Environmental Linkages candidate was originally proposed as a pattern for a proposed Green New Deal pattern language [34]. This linkage was present in the original GND that was proposed to the US Congress, but the thought was to formalize it because other people working in this realm might not realize that it is a core principle. We selected this pattern to begin work on at least partially because of the strong endorsement of those who participated in the online assessment (17 ins, 2 neutrals, 0 outs). The interesting thing to see was how much this focus on the linkage between the two perspectives was present in the LIMITS papers — perhaps all of them. Finally, exploring this principle as a pattern helped promote thinking on how it might become more usable, but it is currently very much a draft.

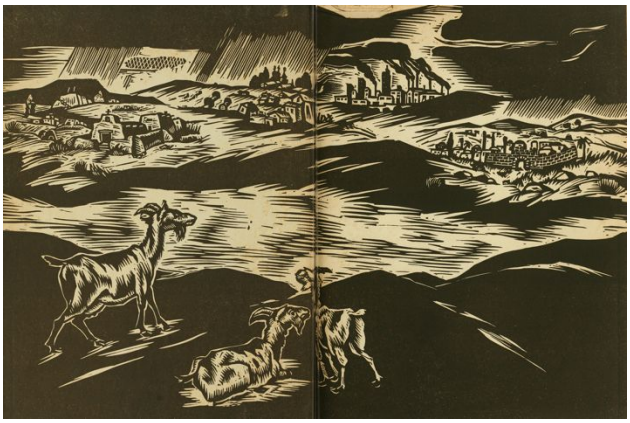

Fig. 4. Todros Geller - Todros Geller - Fun Land tsu Land (From Land to Land) - 1937 – endpaper. Public domain.

Links

Local knowledge, Power Research, Voices of the Unheard, Follow the Money, Grassroots Public Policy Development, Self-Designed Development, Environmental Impact Remediation, The Commons, Arts of Resilience, Citizen Tribunal, Environmental Impact Mitigation, Salvage Computing, Transparency

Problem

The fact that the social world of trade, culture, consciousness, etc. influences the environmental world — and vice versa — is obvious to anyone who thinks about it. On the other hand, questions about what to do about those linkages and where to go with them, are often omitted or undervalued in relation to considerations that focus to one world or the other. Some environmental remedies may end up hurting precarious communities [2].

Identifying environmental degradation and tipping points for environmental crises, clearly two important elements of environmentalism, are by themselves insufficient for addressing them. It is also the case that trying to inject technology into a situation without thinking of the linkages is likely to result in

unintended consequences; work in the social world to distribute it, advocate for it, adopt it, reject it etc. must be part of the program.

Context

Linking social and environmental factors should be inherent in the work of the LIMITS community—and to virtually any other project concerned about social justice and/or environmentalism. This pattern should be useful, both implicitly or explicitly, whenever analyzing or designing for environmental or social amelioration.

Discussion

The original concept that inspired the work on this pattern was in relation to the Green New Deal. The genius—and the audacity—of the Green New Deal is that it acknowledges that environmental problems such as climate change and species disappearance and social problems such as poverty, mass incarceration, xenophobia, and war are inextricably linked. And like the original New Deal, the Green New Deal is extremely wide-ranging with respect to the magnitude of resources proposed and the breadth of its consideration, which addresses agriculture, energy, transportation, economic security, the environment, and the entire social sphere besides.

Unfortunately, unlike the Green New Deal, policy is often developed around a single goal, often from an efficiency point of view, and often is simply imposed on people. Thus, all countries should reduce their use of oil or coal regardless of how the burden fell and on whom. Realizing the connections between social problems and environmental issues, especially where one exacerbates the other or when reducing one reduces the other, should offer clues as to where to look for interventions.

Which is not to say that this will be easy. As Dobson points out, neither social justice nor environmental sustainability necessarily produces the other [6]. And, for example, if increased environmental sustainability raises the taxes or makes gas prices higher than some kind of resistance is virtually guaranteed. In fact, it's not an easy matter to convince some people that computing can have any detrimental effects on the environment, presumably because the connection is harder to see and because of portrayal as a "green industry" [5].

What Linkages?

Human activity, as we know, is now the main driving force behind the major changes that are now disrupting the Earth's systems. But in many ways this is just the beginning of the story.

We need to know what types of human activities are behind these changes? How do they work and how can they be interrupted or diverted? Sabie, Salman, and Easterbrook, for example, discuss how the computer has revolutionized the field of architecture, allowing new dazzling buildings to be built, but are asking the ICT community to accept the "challenge of providing shelter, primarily housing, in existing and future scarce-resource contexts." [30]

Who are the stakeholders? They include the people who affect the changes, the people who must endure the consequences, and the people in between. What can we do with the information? For one thing, it must be recognized that people in marginalized communities are often also in environmentally compromised areas. Linking the social and the environmental means including people from these communities in any conversation or deliberation that will affect them and find an appropriate approach not as an economic rationalistic imposed "solution" but derived through an ongoing negotiating process.

What Does Computing Have to Do With It?

Computer scientists, researchers, and practitioners—and the people that pay them—are reshaping the world — or at least they are making the reshaping happen more quickly. The impacts of computing are linked to both the social field and the environment, sometimes through propagating ignorance on the global scale, sometimes helping us further our understanding.

What damage are we enabling? What are our roles and which ones can we step into? Powering the cloud has just bypassed the airline industry in terms of carbon and other pollutants. And crypto currency mining, like actual mining, is consuming vast, increasing amounts of energy, reenacting the fairy tale through spinning bits into gold. Computing as a vast collective activity has gone beyond enabling others to cause damage in their own way to being actual, direct producers of damage. Moreover, the hardware we employ (and throw away in record numbers) is constructed using rare earth metals that are acquired under harsh conditions that degrades both human and environmental health [2[.

This pattern suggests that linkages might prove themselves to be important tools. What leverage points might we identify and leverage? The more we know about this the better our chances become. It might turn out, for example, that if the miners in the Democratic Republic of the Congo decided to unionize, then a demand for transparency in supply chains at the same time, might be well-warranted.

The relationship between the social and environmental worlds to be thoroughly considered and explicitly linked in any policy that gets developed.

Seed

Linkages connect stakeholders, tools, outcomes, goals, social and environmental entities and processes. We find and identify existing linkages. But, crucially, we also invent them. The LIMITS community links computing with sustainability issues. It also helps establish new links between people.

Linkages is an important concept but we need to go beyond that. We need to seek out the value of knowing about linkages. How can we help identify, hypothesize, leverage, illustrate, write stories about, rewrite, rewire, or create new necessary linkages?

Local Knowledge

Pattern Introduction

Local knowledge refers to the contextual knowledges of the people about themselves and their situations. Often times, they know more about the problem(s) than experts. Thus, by taking into account practices that exist at local/regional levels, this pattern could serve as a model for transition towards a sustainable circular economy.

Fig. 5. This image depicts Kamayan or kinamot, the traditional Filipino method of eating, where food is served on banana leaves and eaten without utensils

Links

Spiritually grounded activism, Social and environmental linkages, The Commons, Environmental Impact Remediation

Problem

Global environmental problems are influenced by local circumstances and vice versa. Whether it be issues of inappropriate resource utilization or environmental pollution within Information and Communication Technology, the effects are varied depending on geography. Thus, to tackle issues which are seemingly global in nature, actions need to be localized in accordance with the immediate and major issues of that particular region. Here, local knowledge of indigenous populations comes into picture. This pattern tries to make use of this existing knowledge with the pretext that the knowledge and commitment of locals could serve as a model for transition towards a sustainable circular economy.

Context

When considering the application of any 'modern' or scientific environmental management, one must take into account the indigenous knowledge of the resident communities. As Fishel and Nelson wrote, "What is known, questioned or created at the local level in diverse communities around the world is too often commodified, trivialized or ignored." [7] Thus, grounding one's public engagement in a way that includes them can lead to productive and insightful action. Involving the local community has shown to have had fruitful results in the past, for instance the Chipko movement in India.

However, such efforts can become highly charged and sometimes even contradictory with other local communities. Contemporary societies and communities vary widely in how well they receive such initiatives -- a martyr to one group will seem like a dangerous radical to the opposition. Intermingling politics and religion can taint both, leading to false pieties in politics and making mundane the prayers and rituals which were originally spiritual in purpose.

Discussion

One of the most important stakeholders in any action or implementation are the people directly affected by the changes i.e. the local population. Thus, it is easy to understand why they should be included in discourses while working out a solution. Their knowledges include expertise of the geography of the area as well as the knowledge of sacred texts, religious doctrines and traditional spiritual practices that exist.

Local populations, especially those who have lived on the land for generations, have a deep understanding of the land as well as the culture. They can study trends and shifts in framework more efficiently. However, when seen only through a global lens, this ground-centric approach does not get its due and it leads to lack of involvement of the community. This exclusion of the local puts the already marginalized at a further socio-economic disadvantage, and reinforces the already existing divides (north-south, rich-poor). When seen within the ambit of ICT, this leads to waste, or rather inappropriate use, of natural resources with a lot at stake but very little to gain for indigenous populations.

This pattern can be illustrated by a series of historical examples intended to suggest its scope. The possibilities are many and varied. As an instance, Gandhi practiced and advocated "Ahimsa," the non-violent struggle for truth, inspiring and his part of the anti-colonialist movement in India to center on that strategy. Derived from Hindu tradition, Ahimsa applied to all features of their lives, from confrontations with the British to the ways they lived and ate and worked together. Similarly, Martin Luther King, working within the Christian tradition, was able to find the religious inspiration for a similar approach to non-violence while basing it in the US Civil Rights movement. Thich Nhat Hanh and his fellow Buddhist monks used self-suffering in the Gandhian tradition to oppose the war in Vietnam. The strategy continues in use at the state level in the struggle between Tibetans under the leadership of the Dalai Lama and the Chinese government. Their practice is both a strategic imperative and an injunction which works well since the leaders adapted it according to their contexts. A narrative on the opposite end of the spectrum could be the citizen protests in Brazil against the destruction of Amazon, which could also be seen as one of the most severe but not uncommon protests by the indigenous populations against foreign and invasive forces.

Seed

The local knowledge pattern should ideally be practiced using a bottom-up approach. The ultimate aim of developing such a pattern would be to have multiple local communities reacting to issues in their particular ways leading to a response that is effective at the global scale. At this juncture, however, it is important to create an awareness of the existence of local knowledge traditions and practices. The patterns should help us actualize these practices in a way that global forces do not overpower them. The pattern would aim to demonstrate local knowledge which are based locally but can be adapted globally.