

Design Patterns for Customizing Irrigation Governance

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Abstract. How can experience with good solutions for institutional design be shared in ways that help customize governance for diverse situations? In their pattern language for architecture and regional planning, Christopher Alexander and colleagues identified patterns, primarily based on successful vernacular architectures, which could be selectively combined and customized to fit particular situations. Similarly, institutional design patterns could be helpful in creating and adapting governance for commons. A semantic mediawiki could offer a useful platform for sharing design patterns, and collaborating to identify and develop design patterns, as part of the semantic web. Elinor Ostrom's design principles for commons, and principles for irrigation governance identified by Trawick illustrate design patterns useful for customizing irrigation governance.

Key words: Institutional analysis and development, institutional artisanship, crafting commons, irrigation management, water governance

INTRODUCTION

Institutional design principles (E. Ostrom 1990) offer important insights into how to develop effective organizations for managing irrigation and other shared resources. However, the application of such ideas risks being oversimplified into inflexible blueprints, "panaceas" crudely imposed without consideration of the appropriateness and without adaptation to local circumstances (E. Ostrom 2007a, Cox, Arnold, and Villamayor 2009). One way to diversify the application of institutional design principles (E. Ostrom 2007) is to use them not as answers but as questions, starting points for discussion: Who is included or excluded? How will benefits and costs be shared? Who will monitor? How will rules be enforced? The answers would then depend on particular conditions, the knowledge and preferences of those involved, and the processes through which they work together to craft institutions.

In a similar spirit of supporting institutional artisanship (V. Ostrom 1980), another way to diversify application of institutional design principles would be to use the principles, and more specific rules and practices, as a basis for design patterns (Alexander et al. 1977, 1979). These would describe good institutional arrangements that deserve consideration in designing governance of shared resources, which could be chosen, combined and customized to fit particular situations. Such recurrent patterns identify landmarks that help map and understand the design space of options for crafting institutions. Institutional design patterns can identify time-tested ways of arranging collective action, explain factors to be considered in application, and offer examples. Design patterns could help inform institutional

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artisanship by resource users, managers and those working with them, to diversify institutional design. The intention is not to replace but to supplement and enhance existing processes of institutional artisanship by resource users and managers.

This paper talks about how institutional design patterns could be used to share ideas about irrigation governance. It begins by reviewing work by Elinor Ostrom, Paul Trawick and others on institutional design principles, generally and more specifically for irrigation. The paper next discusses the pattern language for architectural design developed by Christopher Alexander and colleagues, how similar ideas about design patterns have been applied in software development, and a template for institutional design patterns. Ways of using semantic wiki software to share and develop institutional design patterns are then outlined.

DESIGNING FOR INSTITUTIONAL DIVERSITY

Research on how people govern irrigation systems, forests, fisheries and other commons has revealed an enormous diversity of rules, ingeniously crafted to fit various circumstances (Ostrom 1990). There is no “one best way” to manage all commons or even a particular kind of commons. At a higher level of abstraction, Elinor Ostrom (1990) did succeed in identifying “design principles” found in many long-enduring common property regimes, including irrigation (E. Ostrom 1992). A recent review (Cox, Arnold, and Villamayor 2010) of research using and testing the institutional design principles has generally confirmed their applicability, while proposing a few specific adjustments. Figure 1 summarizes the design principles, with brief titles to identify key elements.

Focusing more specifically on small irrigation systems, Paul Trawick and colleagues have built on the work of Robert and Eva Hunt, Walter Coward, Elinor Ostrom, and others to identify a common set of institutional design principles in irrigation governance, as shown in Figure 2. These overlap with Ostrom’s principles on several points, while being more specifically concerned with the particular characteristics of water and irrigation infrastructure, primarily for small, locally-governed, canal irrigation systems drawing on surface water from streams or rivers.

There is a risk that institutional design principles are taken as identifying the best or only way to organize, becoming the basis for imposing a new set of outside prescriptions, which may be poorly fitted to actual conditions. One way to recognize the value of such principles, without assuming they can be used everywhere and without adjustment, is to suggest that principles, such as proportional division of available water (rather than quantitative allocation), offer a better starting point, or “default” settings,” compared to conventional engineering approaches to irrigation design. As mentioned earlier, principles can also be used as a basis for questions, which can be seen as exploring and considering the “design space” of alternatives around a particular starting point, which could help make discovery much quicker and more efficient.

The thesis of this paper is that such “principles” can also be seen as design patterns, for consideration and potential application. They provide useful landmarks in a design space of possible options. They need not be seen as mandatory “best practices,” but as components available for consideration and customization. They would deserve consideration since they have been tested by time and proved their

continuing worth in many cases. Their suitability in particular case, how they may be adapted, and how they can be combined with other principles, then become something to examine.

Design patterns can thus be applied not only to broad principles, but also to more specific solutions, such as:

- water shares used to define rights to water and duties to contribute
- rules for water distribution, including but not restricted to *warabandi*-type timed turns where irrigators take water in sequence along a canal (and so monitor each other); proportional division common in dividing steady flows in rice irrigation; and filling upstream fields first, common in spate systems.
- ways of dividing land, permanently or temporarily, to equalize water access and the impact of shortages (such as *atar* allocation of plots in head, middle, and tail areas in the northern Philippines and *bethma* temporary reallocation of plots for dry season cultivation near tanks in Sri Lanka)
- watermasters and other roles, common in traditional systems, which differ from the modern tendency to assign collective responsibility through a board structure with president, secretary, treasurer, etc.
- community organizers, also known as institutional organizers and facilitators, who act to stimulate and catalyze collective action, (with important considerations concerning whether they are recruited from outsiders such as recent graduates, from agency field staff, or from within the community)

Rather than being limited by comparison with a single example (which may be idealized and unrealistic) design patterns can help to expand the range of relevant options to be considered, in a practical way that can inform institutional crafting. The potential for using such patterns to diversify institutional design comes from a selective and flexible approach to using design principles, and from the enormous number of possible combinations which can be created from even a relatively small set of alternatives for adapting and combining principles. Just as the structure of a language can be used to create a huge number of sentences, so design patterns can be combined to configure many different institutional arrangements. Within this large and diverse design space, abstract institutional design principles help identify landmarks, attractive regions with kinds of designs that have tended to be effective, and merit attention in trying to figure out what may be most suitable for a particular case.

Figure 1. Institutional Design Principles

- 1a CLEAR USER BOUNDARIES: Clear boundaries between legitimate users and non-users must be clearly defined.
- 1b CLEAR RESOURCE BOUNDARIES: Clear boundaries define a resource system and separate it from the larger biophysical environment.
- 2a RULES FIT LOCAL CONDITIONS: Appropriation and provision rules are congruent with local social and environmental conditions.
- 2b BENEFITS PROPORTIONAL TO INPUTS: The benefits obtained by users from a common-pool resource, as determined by appropriation rules, are proportional to the amount of inputs required in the form of labor, material, or money, as determined by provision rules.
- 3 PARTICIPATION IN MODIFYING RULES: Most individuals affected by the operational rules can participate in modifying the operational rules.
- 4A USERS MONITORED: Monitors who are accountable to the users monitor the appropriation and provision levels of the users.
- 4B RESOURCES MONITORED: Monitors who are accountable to the users monitor the condition of the resource.
- 5 GRADUATED SANCTIONS: Appropriators who violate operational rules are likely to be assessed graduated sanctions (depending on the seriousness and context of the offense) by other appropriators, by officials accountable to the appropriators, or by both.
- 6 LOW-COST CONFLICT RESOLUTION: Appropriators and their officials have rapid access to low-cost local arenas to resolve conflicts among appropriators or between appropriators and officials.
- 7 RIGHTS TO ORGANIZE: The rights of appropriators to devise their own institutions are not challenged by external government authorities.
- 8 NESTED ENTERPRISES: Appropriation, provision, monitoring, enforcement, conflict resolution, and governance activities are organized in multiple layers of nested enterprises.

Sources: Ostrom 1990; 2007 ; Cox, Arnold, and Villamayor 2010. Some titles (in all caps) reworded to be more evocative names.

Figure 2. Principles of Community Irrigation

1. AUTONOMY – the local community or farmer organization has and controls its own water flows.
2. CONTIGUITY – fields receive water allotments in an order that is systematic and uninterrupted in terms of the movement of water utilization through space.
3. UNIFORMITY - everyone receives water from any major source with the same frequency, or has an equal chance of getting that opportunity within a specified period of time.
4. PROPORTIONALITY - individual water rights are related proportionally to land ownership, as are accompanying duties to contribute to the operation and maintenance of the irrigation system.
5. TRANSPARENCY – the rules for allocation and use of water are known to all users and compliance is capable of being monitored by all.
6. REGULARITY – the rules for allocation are always the same under scarcity, with no exceptions allowed and unauthorised expansion of the system prohibited.
7. GRADUATED SANCTIONS – penalties for rule violations are severe but vary according to the gravity of the offence.

Sources: Trawick 2001a, 2001b, 2003, 2007

DESIGN PATTERNS

A pattern language for architecture

Influential work by Christopher Alexander and colleagues identified a set of forms for the design of homes and communities, mostly emerging from vernacular artisanship. They sought to understand why traditional designs for homes and towns worked well. The theory was explained in *The Timeless Way of Building* (Alexander 1979). *A Pattern Language: Towns · Buildings · Construction* (Alexander et al. 1977) lays out the “language” itself, primarily through 253 specific examples. Figure 3 is an example of one of the patterns identified in *A Pattern Language*, about access to water.

The patterns range in scale, from broad regional planning to details of windows and doors. Each starts out with an evocative pattern name, intended to capture key ideas in a memorable way. A photograph shows a real example of the pattern. The pattern is set in the context of other patterns within which it may fit. A “headline” identifies the essence of the design problem, in one or two sentences. The body of the text then explains the background for the design, evidence for its validity, and

different ways it may be manifested. The solution is then stated in the form of an instruction. A diagram shows the key ideas in the pattern. The final section discusses other patterns that can be used to complete the design, helping the reader understand the how specific patterns are linked in the pattern language. Fonts were used to clarify, with pattern names written in capital letters, and the problem and solution in bold.

As with spoken or written language, patterns can be combined in various ways to generate an almost infinite number of sentences. A pattern *language* goes beyond a list or catalogue of styles to identify a well-tested set of compatible patterns that work well together. The pattern language is intended to enable architects and regional planners to combine patterns to create vital, enjoyable spaces at multiple scales.

Figure 3. Pattern 25: Access to Water

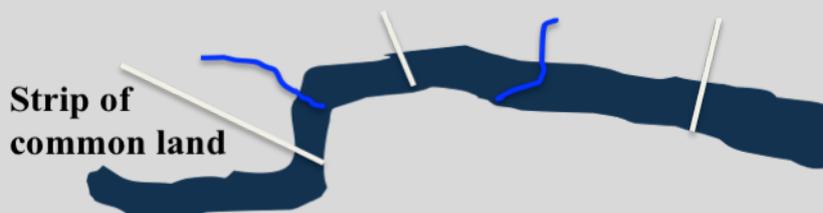
25 ACCESS TO WATER

... water is always precious. Among the special natural places covered by SACRED SITES (24) we single out the ocean beaches, lakes, and riverbanks, because they are irreplaceable.

People have a fundamental yearning for great bodies of water. But the very movement of people toward the water can also destroy the water

- Either roads, freeways, and industries destroy the water's edge... or it falls into private hands
- People will build places *near* the water because it is entirely natural; but the land immediately along the water's edge must be preserved for common use

Always preserve a belt of common land immediately beside the water.



* * *

The width of the the common land will vary with the type of water and the ecological conditions. ... PROMENADE (31). In another case it may be a swath of dunes...
Abridged from Alexander et al. 1977 *A Pattern Language*. 336-340

Design Patterns for Software

In computer software, pattern languages have been used to encourage elegant and efficient programming, particularly during the emergence of object-oriented programming. Design Patterns by the "Gang of Four" (Gamma et al. 1994) were an

influential source of ideas for use of patterns. The authors described twenty-six patterns, as a way to help people recognize patterns, share ideas, discuss designs, learn quickly, and reuse software.

While Alexander and colleagues sought to distill the essential ideas behind traditional design, software design patterns have focused on sharing new ideas in an emerging field where there were few examples to draw on. The patterns were intended to accelerate learning, and make programming more effective and efficient.

The Gang of Four used a more detailed template to describe patterns, including name, intent, motivation, applicability, participants, collaborations, diagram, consequences, implementation, examples, and see also. Their approach was still aimed at helping understand what kind of problems the pattern could help solve, what should be considered in choosing the pattern, and how it could be applied.

Reviewing various applications of software design patterns, Meszaros and Doble (1997) proposed a more general template for writing design patterns. They identified four mandatory elements: a pattern name, context, problem, and solution. These could be accompanied by optional elements: indications, resulting context, related patterns, examples, code samples, rationale, aliases, and acknowledgements.

Templates for Patterns

Figure 4 shows a template for institutional design patterns. It is largely based on the elements used by Alexander; a short evocative name, a context, a problem, forces at work, a concisely stated solution, examples, and a graphical illustration.

Figure 5 is a worked example, for the case of graduated sanctions, one of the design principles found by Ostrom, which is also included in Trawick's principles. The title, "graduated sanctions" captures the key idea. The context concerns enforcing rules. The problem is that rigid enforcement, especially for an initial violation, is difficult or impossible, especially where there is scope for misunderstanding and confusion, interpretations are debatable, and the desire is to have a robust system tolerant of human fallibility. Strict and severe punishment may backfire, leading to rejection and evasion, and polarized conflict that undermines the whole system of rules. The section on forces then mentions the empirical finding that initial sanctions are often relatively mild, more a matter of social pressure on reputation rather than calculated economic incentives. In writing rules, it is impossible to anticipate all the circumstances. People may break rules out of ignorance or exceptional conditions, making it useful to have a way of teaching them which is not overly harsh. These considerations lead to the commonly found solution of starting with warning and mild penalties, while having more severe punishments available if necessary.

The same format can be used for other principles, helping to put them into context and show how they may be applied. This can be particularly useful for someone searching for a solution. They will not be interested in reading through long, dense text during their initial search, but may want more detail once they have focused in on a particular pattern. The format helps to quickly identify whether the pattern is relevant, and if so, to locate the useful information.

Figure 4. Pattern Template

EVOCATIVE PATTERN NAME

Context: may be part of

* * * *

Problem

- Forces to be considered, ways the pattern may appear

Solution

Diagram

Examples of the pattern in use

* * * *

Related patterns: alternative solutions; may contain

Notes

Sources

Figure 5. Example: Graduated Sanctions

GRADUATED SANCTIONS

... in enforcing rules

Penalties are necessary, but overly strict punishments are unworkable

- Customary governance often relies on subtle sanctions, e.g. gossip, reputation
- People may break rules due to ignorance, misunderstanding, ambiguous wording, or special circumstances
- Punishing neighbors and relatives is difficult, but sometimes necessary

Start with warnings and then mild penalties, with more severe punishments for repeated, deliberate violations

Initial violations may be met with verbal explanations and warnings, followed by small fines (token or symbolic), with substantial fines only imposed after repeated offenses

SHARING IN THE SEMANTIC WEB

In order to be applied, tools such as the design patterns need to be accessible. Governance institutions, for irrigation and other resources, need to be customized to fit particular situations. So design patterns need to be made available so that they can easily be found and applied.

A website with links obviously offers a useful framework for sharing information about design patterns. The spread of internet capable mobile phones and other accessible networked computers is showing that stereotypical assumptions about a dualistic “digital divide” need to be rethought in order to effectively understand the opportunities created by expanding, multi-lingual, multi-format (spoken, visual, and textual) access to information and communication. While outsiders with specialized knowledge and skills may sometimes play a valuable role, insiders, such as irrigation farmers, increasingly have direct access and ability to use available information from the web and other sources. There are also additional ways to take advantage of the opportunities for communication and collaboration created by computers and the internet. In particular, Wiki-type software can encourage collaboration in developing institutional design patterns. It may be noted that Wikipedia itself is not suitable, since it is intended as a reference for already established knowledge, and does not allow self-publication by researchers.

Ordinary wiki software does not impose any particular structure on the information. For structured information, such as design patterns, a structured format is more appropriate. This can also contribute to the creation of the “semantic web” (Berners-Lee 2001) where structured information is linked in ways that are meaningful and searchable for both people and computers. Since the patterns are arranged in a structured format, semantic wiki software can incorporate that structure, while enabling collaboration, including discussion, citations, and links to examples.

Semantic web software is an area that is still under development. Referata.com is one of several sites which are available to host semantic wikis. It is based on the mediawiki software used for Wikipedia and other projects. Referata adds extensions for semantic structures. Semantic mediawiki software thus offers a possible platform for identifying, sharing, and refining design patterns, and facilitating their application. A prototype based on the ideas in this paper is available at <http://designingcommons.referata.com>

CONCLUSIONS

Design patterns provide a concise and practical way to explain tested solutions to design problems, and how they might be applied. They thus become part of a toolkit or set of ingredients that can be considered for application by resource users and those working with them.

Formulation in terms of a pattern language goes beyond a list of traits or catalogue of variations to identify a set of compatible forms. Formulation as a pattern language can go beyond a neutral or positivist science assessing frequency or robustness of particular principles, to offer normative recommendations about forms that may contribute to enhancing values, such as self-governance, conviviality, and meaning. In contrast to imposing idealized, standard models, pattern languages of institutional forms offer a tool to diversify and customize designs for governance of irrigation systems and other commons.

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