

Pattern Sequences

Neil B. Harrison

Avaya

1300 West 120th Avenue

Denver, CO 80234 USA

+1 303 538 1541

nbharrison@avaya.com

James O. Coplien

North Central College

10 North Brainard

Naperville, IL 60566 USA

+1 515 779 7421

JOCoplien@cs.com

ABSTRACT

1. Introduction

At EuroPLoP 2001 we had a session on pattern sequences. It started with a small exposition of ideas from Alexander, mostly from his explicit discussion of sequences in a draft of his forthcoming work *The Nature of Order*. But the meeting quickly segued into stories from experience, including some brilliant sequences from workshop attendees. There were particularly powerful contributions from Alan O'Callaghan and Rebecca Rikner.

Neil Harrison and Jim Coplien decided to get something started here that recalls and captures that experience. If you have ideas to add to this, please write to us at the above addresses.

2. Whither sequences?

We pattern folks have gathered patterns, but have not gathered sequences. Nevertheless, the sequences were there all the time, we just didn't notice. And we were registering them unawares.

A sequence is one path through a pattern language. It is the process we follow to build something.

After we got a critical mass of patterns (in an area), we could arrange them in a language (static), and we could trace sequences through the language. The sequences we trace may well have come from the sequences that lodged themselves in our brains earlier.

3. Comparison to Patterns

Note that patterns happen in much the same way. We didn't notice patterns, either. After the fact, the patterns began to emerge. But sequences are a level beyond patterns; they are even harder to immediately perceive. You may be able to get at them only through patterns—like moving leaves make wind visible to us, patterns make the sequences visible.

To get it [a sequence], a static pattern language similar to the languages illustrated earlier, was then re-stated as a generative sequence. In its sequence form it shows the user the process of unfolding, in sequence, in such a way as to allow a good building to be made, very easily, for the particular conditions of a given site. (Christopher Alexander, *Nature of Order Volume 2*, p. 303)

Now, think about the master builder—master builders don't use patterns consciously, nor do they use sequences consciously. The patterns just flow from one to another. See comment below under *Architecture*.

4. Piecemeal Growth and Iterative Refinement

Indeed the nature of order is interwoven in its fundamental character with the nature of processes

which create the order (Christopher Alexander, *The Nature of Order*, p. 8)

The idea is that you build beautiful systems using the *fundamental process*: order comes from the process that creates the order. Alexander describes the fundamental process as a self-unconscious way of creating beauty through the construction of centers. Centers are just psychological constructs that correspond to the structures we notice in systems; they have ill-defined boundaries and bleed into each other. The steps of the fundamental process are:

- Absorb the wholeness and feel its deep structure
- What can we do next to give it the most positive increase of life?
- As we do that, direct attention to the center that can be evolved to this end
- As you create a new center, do so in a way that intensifies an existing center
- Make another center of the same size, creating local symmetry
- Reflect on the system to determine if the wholeness has increased. Undo the change if it hasn't.
- Repeat
- Stop when done

Process is key to making life in things—a point we structural people often miss in patterns. So we go through a process trying to preserve structure while creating structure—that's what your thesis is about... Systems grow by a process of unfolding: step-by-step adaptation with feedback. And there is unpredictability, too, ever guiding one's path through the language in a dynamic awareness of the Whole.

Each step of the process is a structure-preserving transformation. Whether beauty is increased or not is held by Alexander to be an objective judgement. Beauty comes from the configuration of centers. The centers that are created at each step of the process should be related to other centers by one or more of these 15 structural properties (*ibid.*, p. 71):

1. Levels of Scale
2. Strong Centers
3. Alternating Repetition
4. Boundaries
5. Positive Space
6. Good Shape
7. Local Symmetries
8. Deep Interlock and Ambiguity

9. Contrast
10. Graded Variation
11. Roughness
12. Echoes
13. The Void
14. Simplicity and Inner Calm
15. Not Separateness

There is nothing really special about these centers; they are not unique (they overlap each other) and there is nothing special about there being 15 of them. It is the process, not the centers, that are key.

The order in which centers are created during unfolding, during the fundamental process, is of the essence.

5. Sequences and Patterns

Human beings cannot pursue a center-creating process without some general idea of the centers that are to be created, ahead of time. The generic centers are rooted in culture.

The fundamental process cannot work on a human scale without some kind of cognitive guide that is built on experience and which can kind of foresee some of the centers that must be built. That's what patterns are. Alexander says: that a pattern is an essential center (*ibid.*, p. 256). For example, City-Country Fingers is a pattern (Christopher Alexander et al., *A Pattern Language*, p. 21) that reflects Deep Interlock and Ambiguity as well as Alternating Repetition. He also mentions, importantly enough, that the very building of a pattern is itself an unfolding process.

If unfolding is important, how do you know what order to unfold things? The sequence is crucial (slide 9). You want a smooth, structure-preserving unfolding, without the torture of design. He gives several examples including the Japanese tea house.

So, what a sequence does is:

- Preserves structure;
- Keeps you doing one thing at a time;
- Takes the Whole into account at each step;
- May be repeated tens of thousands of times.

A sequence is dynamic: it adds dynamics to pattern languages. Sequences are where generativity comes from.

6. Comparison to Learning Natural Languages

So sequences give the pattern language life. This is the same as the way babies learn to speak and understand. They learn sequences. They start with standard sequences, then move to creating their own sequences. And the sequences create the grammar. And they do it without thinking about it.

7. Application to Software Development

We're still working on this, but we think there are some far-reaching things to be said. It could be a different way of looking at software development. We discuss a couple of possible sub-points below.

How do we create sequences? It is easy in traditional domains or in high-context domains. In other domains, it comes down to following the fundamental process! That means following the weakest centers and intensifying them, one step at a time, in a process of piecemeal growth. That, of course, is hard, because you need to pay attention to so many things at once. Alexander suggests that actual experimentation may be in order (*ibid.*, p. 320). Real software development proceeds this way, and documenting the process by which a system grows this way is a powerful and necessary adjunct to pattern languages.

8. Architecture: "Systems Thinking"

So what makes a good (software) architect? Someone who can visualize the entire system; the entire whole. A good architect must have good command of the sequences the go into the system, and must have them internally (you can't think about the sequences and think about the whole at the same time -- so the sequences must be part of you.) This has repercussions for how people become architects.