Systematization of Patterns for Weaving a Pattern Language as a Whole

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Abstract

This paper presents a method of "systematization" for creating a system of the pattern language. Christopher Alexander, who proposed the pattern language, emphasized that patterns are related to each other and form a network system. However, he did not explicitly discuss how to create a system of patterns, partly due to the fact that, many pattern authors often propose just a collection of patterns, not a system as a language. Based on this background, we have developed our own method of systematization more than ten years of practice in creating pattern languages. The method is as follows: just after the pattern seeds are obtained in the pattern mining phase, the seeds are first grouped with related seeds (bottom-up), and then the significant *cores*, which are categories that make up the whole, that make up the whole pattern language practice are defined (top-down). Then from a bottom-up and top-down approach, each group is respectively connected to one of the *cores*, which is the category that makes up the whole. Finally, suppose the groups do not fit into the categories in a well-balanced manner. In that case, the heart and range of each core is adjusted, which reorganizes the groups. Thus, by combining bottom-up and top-down approaches and making adjustments, patterns can be woven together as a system with wholeness. In this paper, we also introduce some examples of systematized pattern languages that we created.

1. Introduction

Patterns in the pattern language do not exist in isolation but are interrelated to form a system. In other words, pattern language is not a *collection* of patterns but a *system* of patterns. In Alexander's book *The Timeless Way of Building*, he said that "the possibility of language is latent in the fact that patterns are not isolated" (Alexander, 1979, p.309). People who want to produce good quality in a certain area need to combine and conduct multiple patterns that are interrelated, not just use one pattern.

Furthermore, the meaning of each pattern is specified by its placement in the system. For this reason, it is necessary to form a system as well as writing patterns. In other words, it is a process of clarifying the relationships among individual patterns, grasping what the pattern language as a whole is composed of,

and putting it together as a *system*. We call this *systematization*[1]. The *system* is the positioning and relation of patterns that includes the whole's meaning to the parts, as proposed by Alexander. Note that Systematization is carried out in the process of pattern language creation, which we developed and improved, as shown in Figure 1.

In what follows, we will first quote what Alexander mentions, a system of patterns, and then present our method of *systematization* in creating pattern language.

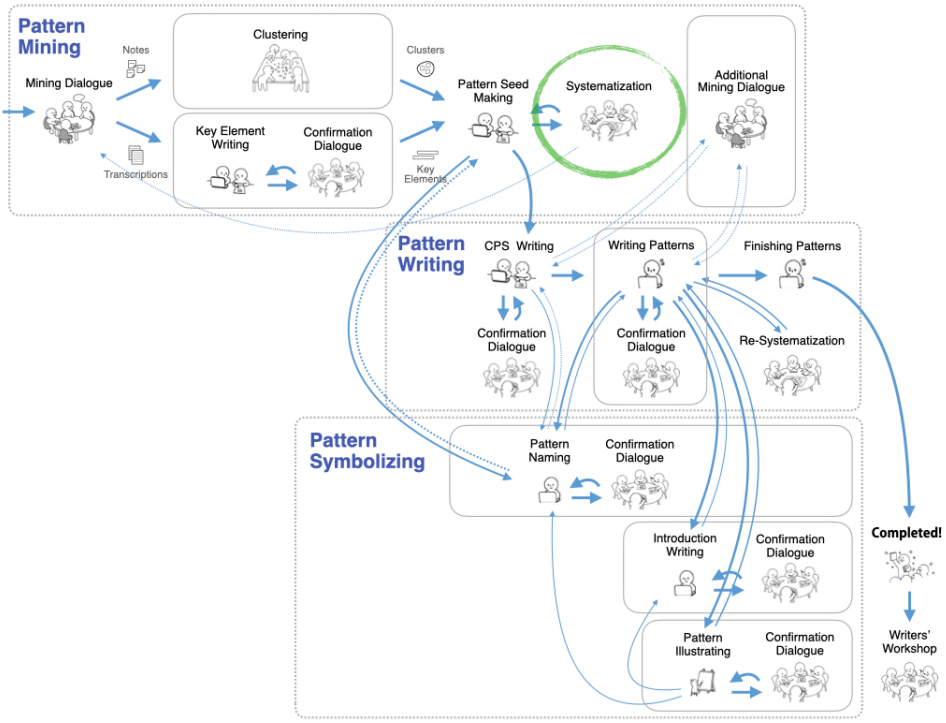

Figure 1: Systematization in the Process of Pattern Language Creation

2. Systematization of Pattern Language

First Alexander explains what a pattern is:

> "Each pattern is a rule which describes what you have to do to generate the entity which it defines." (Alexander, 1979, p.182)

> "Each pattern is a three-part rule, which express a relation between a certain context, a problem, and a solution." (Alexander, 1979, p.247)

It is well known that *Context, Problem*, and *Solution* are the main sections when forming patterns. Patterns that are formatted like so are interrelated. Alexander said, "the system of patterns forms a language" and that "a pattern language is a more complex system of this kind" (Alexander, 1979, p.183) compared to a mathematically defined *language* or a natural *language*. Now, what kind of *language* is it?

[1] Until a few years ago, we sometimes called this work "structure building." We realized that this naming is misleading because people tend to focus on the structural framework. As a result, we came to think that it is better to call it "systematization," which gives the impression that it is weaved together in a systematic way with the pattern.

In the following, we will discuss the structure of the language, and then look at what it means to use a pattern language in design.

2.1 Language Structure

Alexander gives the following explanation.

> "The elements are patterns. There is a structure on the patterns, which describes how each pattern is itself a pattern of other smaller patterns. And there are also rules, embedded in the patterns, which describe the way that they can be created, and the way that they must be arranged with respect to other patterns. However, in this case, the patterns are both elements and rules, so rules and elements are indistinguishable. The patterns are elements. And each pattern is also a rule, which describes the possible arrangement of the elements ----- themselves again other patterns." (Alexander, 1979, p.185)

In other words, a pattern is part of a larger pattern, and also contains a number of smaller patterns within it.

> "Each pattern then, depends both on the smaller patterns it contains, and on the larger patterns within which it is contained." (Alexander, 1979, p.312)

He also says the following:

> "Each one is incomplete, and needs the context of the others, to make sense." (Alexander, 1979, p.312)

> "It is, indeed, the structure of the network which makes sense of individual patterns, because it anchors them, and helps make them complete. Each pattern is modified by its position in the language as a whole: according to the links which form the language." (Alexander, 1979, p.315)

Based on these ideas, the patterns that weaved together become worthy of being called a pattern *language*. This is the difference between a pattern *collection* and a pattern *language*.

> "it is the network of these connections between patterns which creates the language." (Alexander, 1979, p.313)

> "In this network, the link between the patterns are almost as much a part of the language as the patterns themselves." (Alexander, 1979, p.314)

Furthermore, he says that pattern language woven in such a way will produce a lively and good quality pattern:

> "And in virtue of its position in the whole, each pattern becomes especially intense, vivid, easy to visualize, and more richly visualized. The language not only connects the patterns to each other, but helps them to come to life, by giving each one a realistic context, and encouraging imagination to give life to the combinations which the connected patterns generate." (Alexander, 1979, p.315)

Based on the above, Alexander asks, *"how do I know if the language is a good one?"* (Alexander, 1979, p.315). Alexander's answer to this question is as follows:

> "The language is a good one, capable of making something whole, when it is morphologically and functionally complete. It is morphologically complete, when the patterns together form a complete structure, filled out in all its details, with no gaps. And it is functionally complete when the system of patterns has that peculiar self-consistency in which the patterns, as a system, generate only those forces which they themselves resolve --- so that the system as a whole, can live, without the action of self-destroying inner conflicts." (Alexander, 1979, p.316)

> "It is the structure and the content of the language which determine the design. The individual buildings which you make, will live, or not, according to the depth and wholeness of the language which you use to make them with." (Alexander, 1979, p.260)

2.2 Design and Language

As described above, a pattern language woven into a system correctly and functional can be created to have multiple multilayered relationships.

> "When every pattern has its principal components given by the smaller patterns which lie immediately below it in the language, then the language is complete. And you see then what a beautiful structure a pattern language has. Each pattern is itself a part of some larger pattern ---- it is born out of these larger patterns through the forces which occur there, and the conditions which allow these forces to be in harmony. And each pattern itself gives birth to smaller patterns which, once again, through forces which must also be in harmony, gives birth to smaller patterns again created by the conditions which put the lower level forces into harmony." (Alexander, 1979, p.322)

This multilayered structure is not just a recognition that the world is the way it is but also has important implications in supporting design. Alexander sees design not as a combination of parts but as a differentiation of the whole.

> "It is only possible to make a place which is alive by a process in which each part is modified by its position in the whole." (Alexander, 1979, p.369)

> "In short, each part is given its specific form by its existence in the context of the larger whole. This is a differentiating process. It views design as a sequence of acts of complexification; structure is injected into the whole by operating on the whole and crinkling it, not by adding little parts to one another. In the process of differentiation, the whole gives birth to its parts … The form of the whole, and the parts, come into being simultaneously." (Alexander, 1979, p.369-370)

And this process of differentiation resembles "*the growth process of an embryo.*" (Alexander, 1979, p.370).

> "A baby starts from the first day of its conception, as a whole, and is a whole, as an embryo, every day until it is born. It is not a sequence of adding parts together, but a whole, which expands, crinkles, differentiates itself." (Alexander, 1979, p.383)

Alexander explains what kind of process this is.

> "At every stage of development, new structure is laid down, on the basis of the structure which has been laid down so far. The process of development is, in essence, a sequence of operations, each one of which differentiates the structure which has been laid down by the previous operations. The unfolding of a design in the mind of its creator, under the influence of language, is just the same. A language allows you to generate an image of a building in your mind, by placing patterns in space, one pattern at a time." (Alexander, 1979, p.371-372)

In other words, "*The language is a sequence of these operations.*" (Alexander, 1979, p.373), and Alexander describes the effect as follows:

> "Since the patterns are arranged in order of their morphological importance, the use of the language guarantees that a whole is successively differentiated, so that smaller and smaller wholes appears in it, as a result of the distinctions which are drawn. When a pattern language is properly used, it allows the person who uses it to make places which are a part of nature, because the successive acts of differentiation which the patterns define, are ordered in such a way that at each step new wholes are born" (Alexander, 1979, p.373-374)

To understand these ideas properly, it is necessary to follow the idea that the *whole* precedes the parts, which Alexander emphasizes in his book, *The Nature of Order* (Alexander, 2002):

> "the local parts exist chiefly in relation to the whole, and their behavior and character and structure are determined by the larger whole in which they exist and which they create." (Alexander, 2002, p.80)

> "In nature, this follows directly from the fact that parts are induced by the whole and created by the whole. The whole is not created out of them. The flower is not made from petals. The petals are made from their role and position in the flower. This is an entirely different vision of reality from the one we have become used to. In this new vision, it is always the whole, the wholeness as a structure, which come first. Everything else follows from this wholeness …" (Alexander, 2002, p.87-88)

> "… these parts and entities are rarely pre-existing. They are more often themselves created by the wholeness. This apparent paradox (seeming paradoxical only because of the simple-minded way in which it is expressed) is a fundamental issue in the nature of wholeness; the wholeness is made of parts; the parts are created by the wholeness. To understand wholeness we must have a conception in which "parts" and wholes work in this holistic way." (Alexander, 2002, p.84)

Above, Alexander talks about the relationship between the whole and the parts of the buildings and spaces they create. Of course, this also applies to the relationship between the whole and the parts of the pattern language.

This paper will discuss how we can create a system of pattern language based on the above ideas. Unlike Alexander's architecture, the pattern language we create is about human actions (Iba, 2016), but we believe that pattern language criteria should be the same. The following section will introduce some examples from the pattern languages we have created so far and their systems.

3. Examples of Systems in Pattern Language Created in Iba Lab

One of the best examples of a pattern language system would be *Words for a Dialogue* (Iba, *et.al.*, 2017; Nagai, *et.al.*, 2017; Iba and Nagai, 2018). *Words for a Dialogue* is a pattern language for solving problems based on an Open Dialogue approach; This pattern language supports to feel *Experienced World*, from the inside, that the person with a problem, and encourage the *Various Voices* of the people involved in the dialogue, and so reach a *Co-Created Understanding* together. The overview of this pattern language is as shown in Figure 2.

Figure2: Overview of the pattern language, *Words for a Dialogue*
(Iba, *et.al*., 2017; Nagai, *et.al.*, 2017; Iba and Nagai, 2018)

Patterns No. 1 through No. 3 are the main concepts that make up the whole, and fulfilling these three concepts is, roughly speaking, achieving the pattern language's goal. Then, the nine concrete actions allow people to put these three concepts into practice. This is a system in which the wide-range patterns contain the specified patterns—for example, the lower levels of the 1. Experienced World patterns include 4. *As a Living Person*, 5. *Deep Listening*, 6. *Exact Same Words*, 7. *Open Question*, 8. *Pause for Thinking*, 9. *Response to What is Said*, 10. *Inner Viewpoint*, 11. *Tunnel of Emotion*, and 12. *Respectful Mind*.

In practicing dialogue, the first thing to be aware of and keep in mind is the large scope of the patterns, which are 1. *Experienced World*, 2. *Various Voices*, 3. *Co-Created Understanding*. Then, when practicing each of these patterns, the nine patterns below, which specify the context in more detail, come into place.

A description of the nine patterns for practicing the Experienced World pattern in concrete terms in Words for a Dialogue is introduced in the pattern language book, *Words for a Journey* (Iba and Nagai, 2018), as follows:

> **Feel the *Experienced World***
> In Open Dialogue, the manner in which a person dealing with a problem views the world and perceives things is understood through dialogues. The experiences that led to their perspectives can also be understood by listening to their story.
>
> To properly understand their *Experienced World*, you should break free from your role and approach the other *As a Living Person*. *Deep Listening* is important when considering their words so that you can use the *Exact Same Words* to respond.
>
> Instead of 'Yes or No' questions, *Open Questions* must be asked so that they can freely express their thoughts and feelings. It is important to give them a *Pause for Thinking* especially when discussing things that they have not yet been able to put into words. When they share their thoughts with you, ensure to provide a *Response to What is Said*.
>
> To truly understand their *Experienced World* rather than just knowing their situation, it is necessary to see it from their *Inner Viewpoint*. Their pent-up emotions may overflow, but you should understand that it is a *Tunnel of Emotion* that helps them express their deeper feelings

that they have been unable to express in words. In such a case, you should show your *Respectful Mind* for the fact that they have endured difficult situations and help them to express their feelings in words.

Accordingly, you can gradually deepen your understanding of the other person's *Experienced World*.

These nine patterns are also not just randomly mixed, but the relationships between the patterns are woven from their contents. In this way, these nine patterns are combined into one group of three (Table 1). Then, the patterns are structured so that there are three groups under 1. *Experienced World* and each group contain three patterns.

In this pattern language, to avoid a complicated structure, the middle group is deliberately not made into a pattern but rather a cohesive group that is not as represented, making it look like a two-layered structure of categories and patterns. This decision was made because the users of this pattern language, i.e., the book's readers, are the public, and a complex structure may confuse them or discourage them from reading and practicing it.

Table. 1: The layered structure of the pattern language in *Words for a Dialogue* (Iba, *et.al.*, 2017; Nagai, *et.al.*, 2017; Iba and Nagai, 2018)

category	group	pattern
1. Experienced World	Stay Together	4. As a Living Person
		5. Deep Listening
		6. Exact Same Words
	Grasp Everything	7. Open Question
		8. Pause for Thinking
		9. Response to What is Said
	Feel Deeply	10. Inner Viewpoint
		11. Tunnel of Emotion
		12. Respectful Mind
2. Various Voices	Environment for the Dialogue	13. Significant Others
		14. Dialogue Supporters
		15. Sitting in a Circle
	Bring out Everyone's Voices	16. Invitation for Utterance
		17. Slow-Paced Conversation
		18. Chain of Responses
	Understand Everyone's Feelings	19. Tiny Signs
		20. Emotional Response
		21. Reflecting Talk
3. Co-Created Understanding	Foundation for Trust	22. First Meeting in Crisis
		23. Everyday Meetings
		24. Continuous Engagement
	Creative Uncertainty	25. Diverse Understandings
		26. Ambiguous State
		27. Transformation of Meaning
	Bridge to the Future	28. Everything Together
		29. Ever-Widening Context
		30. Community for the Future

Thus, in the pattern language we create, for each work, we decide whether to use the broader concepts like patterns, that is, whether to describe them as sentences in the form of *Context, Problem,* and *Solution*. As a result, categories and groups are often not described as patterns. However, even if they are not written in the form of patterns, categories and groups are named and indicated to create a stream of consciousness that differentiates the whole from the parts. In this way, we have applied Alexander's ideas, considering the practical aspects.

In addition, there is a pattern language that we have created that has three levels instead of two. This is *A Pattern Language for Value-Creation Marketing* (Iba et.al., 2020a, 2020b, 2020c). In this pattern language, nine patterns stem from the core pattern that makes up the whole, and each pattern has several action patterns that are subordinate to it (Figure 3).

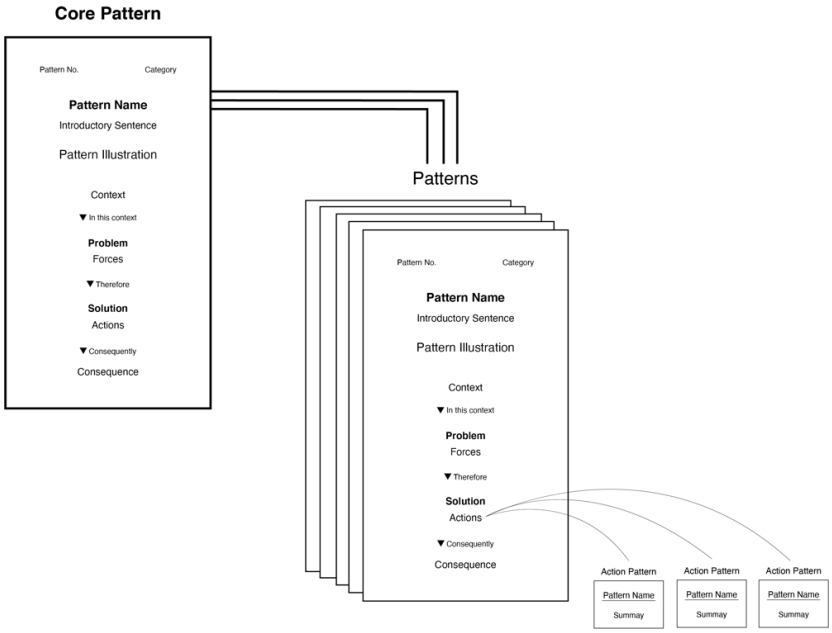

Figure 3: Layered structure of *A Pattern Language for Value-Creation Marketing* (Iba *et.al.*, 2020a, 2020b, 2020c)

There is also a pattern language with many more layers: *A Pattern Language for Creating Pattern Languages* (Iba and Isaku, 2016). 364 patterns are organized into five levels, and all elements of the levels are described in the form of patterns (Figure 4 and 5).

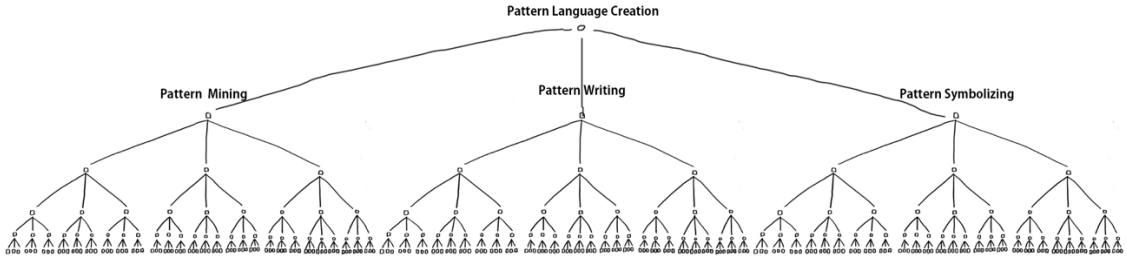

Figure 4: The overall structure of *A Pattern Language for Creating Pattern Languages* (Iba and Isaku, 2016)

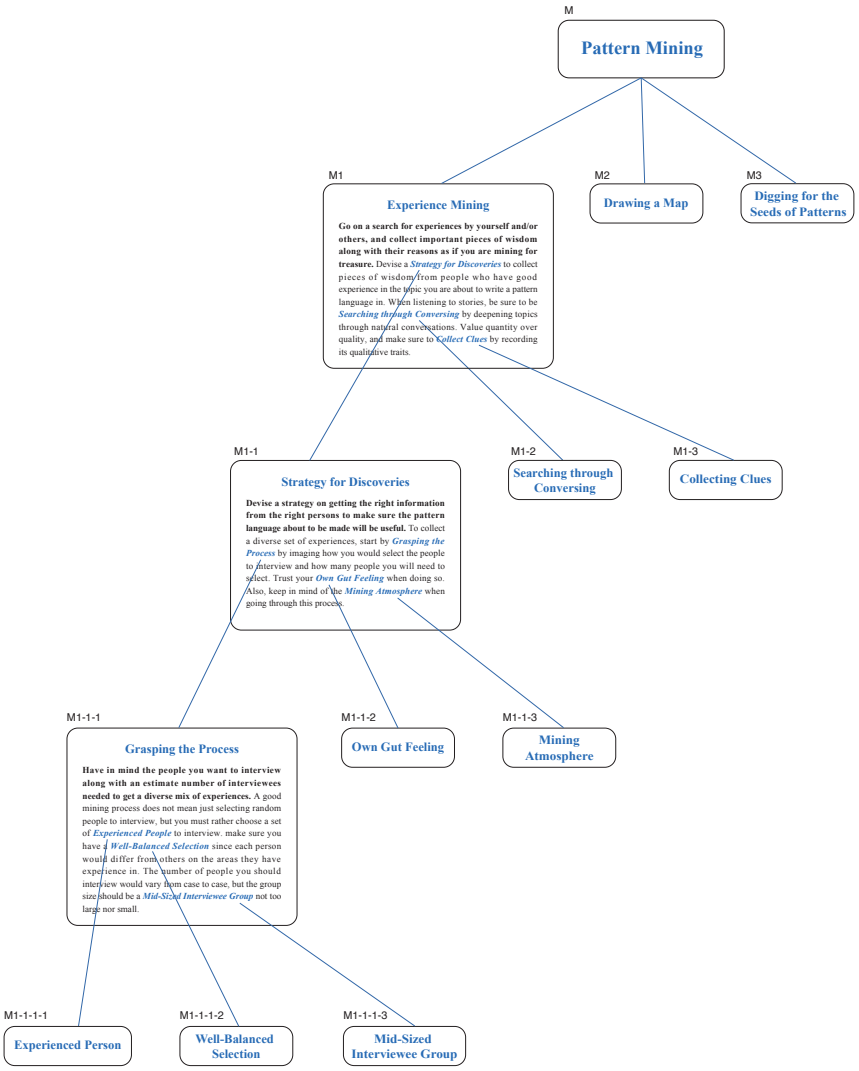

Figure 5: Examples of patterns in the layered structure below the core pattern, *Pattern Mining* in *A Pattern Language for Creating Pattern Languages* (Iba and Isaku, 2016)

Iba Lab has proven that writing pattern languages with many layers in the form of *Context, Problem,* and *Solution* is best suited for professionals in specialized fields. This is because the various levels of wording the pattern are necessary and effective in professional practice and communication. Also, since the patterns are written at high quality using the *Context/Problem/Solution* format, it will be worth learning the ways of the pattern language.

On the other hand, especially when the users (readers) of the pattern language are not professional experts but ordinary people, it makes sense to keep the overall number of patterns small and to reduce the cognitive and learning costs. This can be done by only presenting the elements of all levels as category or group names rather than describing them as patterns.

In any case, the work of "systematization" is essential when creating a pattern language to make it a single systematic language rather than just a random collection of patterns. Unfortunately, however,

Alexander does not explicitly discuss how to systematize them into a language. Therefore, we have been developing and refining our method of systematization in our practice of creating pattern languages.

After more than ten years of experience, we have finally settled on a method and have come to talk about the key points. In this paper, we would like to introduce our way of systematization.

4. Proposed Method of Systematization

In the proposed method for systematization, you use the bottom-up approach, and once all the patterns are roughly grasped, you work from the top-down approach to create the overall structure (Figure 6). Then the order of the patterns is determined, considering the natural flow of reading the patterns. In the case of systematizing 30-40 patterns, this process often takes 8 to 10 hours (this may vary depending on the person's experience with systematization).

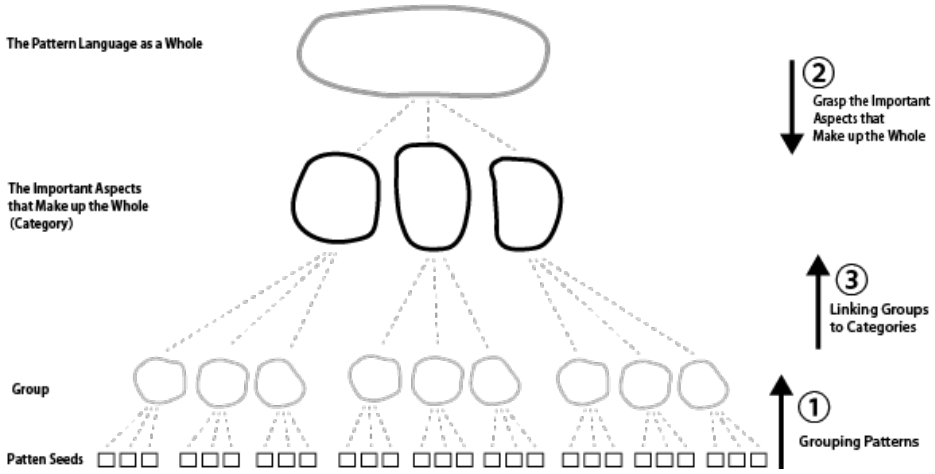

Figure 6: The process of systematization consists of using both bottom-up and top-down approach to build and support the system

4.1 Begin by Pattern Grouping

The steps for systematization are as follows (Figure 7). The first step is to write down the pattern names and summaries of each *pattern seed* as a single element, arrange them and gaze at them. In the pattern language of human actions, there are usually about 30 to 40 *pattern seeds*.

Then you bring together pattern seeds that you *feel* are close to each other, eventually forming small clusters. The objective here is to create *groups* that consist of about three patterns each. There is no need for there to be precisely three groups at this stage, but it should be remembered that the goal is to create an estimate of three groups.

By grouping the 30 to 40 pattern seeds into three or so groups of 10 to 15 pattern seeds, it is easier to grasp what patterns are there. At this point, you can look at the groups, keep them in mind, and move on to the next step in the process.

Now, when grouping the similar pattern seeds, you are not looking at what the *solution* does, but rather what *problem* it is trying to solve. It is difficult to judge whether the pattern you are creating covers the entire range of activities in that area. Another crucial role when systematizing is to check whether the *problems* are covered to build a foundation of the patterns. By understanding what each problem means, you can grasp the group as a whole.

As Alexander says in his book, *Notes on the Synthesis of Form*, problems are easy to point out. It is only with the problem that is linked to the solution that you can check whether the quality of the overall

goal (e.g., well-being in life, living out of one's way, creative management, growing a startup, etc.) covers the major issues without holes. Therefore, the problems are laid out as the foundation of a web structure. You can improve the groups by applying solutions that eliminate individual problems and enhance the whole.

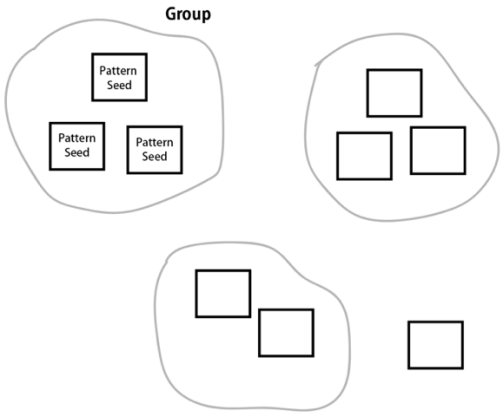

Figure 7: Create groups of about three patterns that are similar to each other

4.2 Three Main Aspects that Make Up the Whole

From this point on, a clear change in your mindset is necessary because you will switch your perspective to the top-down method. Now, to achieve the goal of the pattern language (e.g., creative collaboration in *Collaboration Patterns* (Iba and Isaku, 2013; Iba and Iba Lab, 2014), creative hospitality in *Omotenashi (Hospitality) Design Patterns* (Iba and Nakagawa, 2019; Umewaka, *et.al*, 2020), dialogue for collaborative problem dissolution in *Words for a Journey (Iba, et.al., 2017; Nagai, et.al., 2017; Iba and Nagai, 2018)*, etc.), you must categorize the three groups into three parts. To do so, you must ask yourselves what the three essential factors are. When doing this, don't go back to square one, but recall the 10-15 groups that you just created in mind. The point here is to grasp the three categories that make up the whole of this pattern language.

If no group (pattern group) fits into the category, then the category will not work. For this reason, it is best to *vaguely imagine* about ten to fifteen groups. Note that I use the phrase "vaguely imagine." It is not simply a matter of classifying groups of ten to fifteen into three categories.

Simply categorizing groups from the bottom-up method is not enough because while they may summarize the parts well, it often lacks clarity and does not appear to grasp the essence of the *three main factors* when viewed as a whole. In other words, they are likely to be elusive and unimpressive (not conveying a message). Therefore, in this top-down stage, the focus of thought should be on clarifying the three essential aspects of the whole (while considering the parts).

By focusing on the essence of the categories as a whole, you can perceive the essence of the three main points that must be done to realize what you want to achieve as a whole in this pattern language.

You will be able to see what three categories the patterns should be divided by and how those parts can express the essence of the whole by looking at the contents individually and absorbing it within yourselves. Then, you can think about how the whole can be divided into three parts (Figure 8).

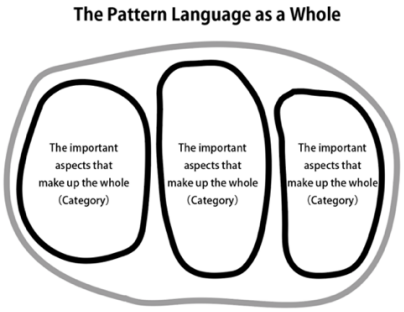

Figure 8: Think about the three important aspects that make up the whole of the pattern language

4.3 Apply the Groups to the Three Overall Categories

The next step is to make sure that the three or so groups of patterns created initially are well balanced in the three potential categories (Figure 9). It is likely that, contrary to the initial assumption, many groups will concentrate on one category, and other categories will have a few groups. Therefore, you must reconsider what kind of three categories would represent the whole and be the essential three categories that would achieve the purpose of the pattern language.

Or, conversely, you can think about what groups would accurately correspond to the categories. A pattern may have a particular nuance in one group but a different nuance in the other group (but not too far off from what the pattern is trying to say). By making such adjustments in parts, you can also review the three categories as a whole.

There is a need to remember that neither the part is determined first nor the whole. The part and the whole are interdependent and can change, so you go back and forth from part and whole, which is the correct process of systematization. The work does not go on indefinitely, but at some point, it reaches a stage where it is a perfect fit and cannot be changed any further. Until you get the feeling that *Seeking its Complete Form* (Iba and Adachi, 2021) has finished, it is necessary to engage in the trial-and-error process diligently.

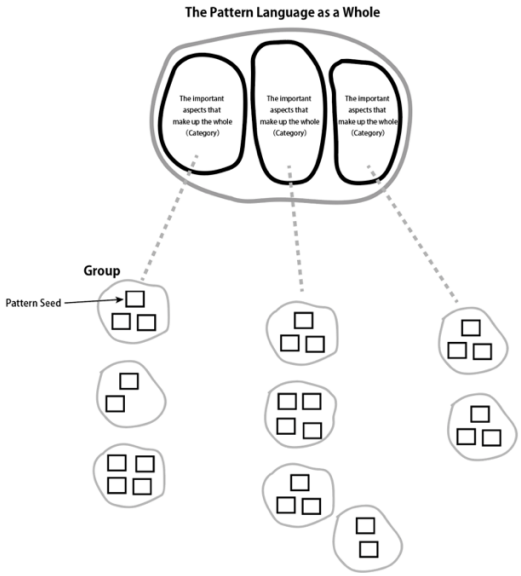

Fig. 9: Try to arrange the group into three categories.

4.4 Order of the Patterns in the Group

The first pattern in the group is usually the most straightforward, important pattern of the group and is representative of the group (Figure 10). Sometimes the patterns are placed in order based on the pattern. If the less important or distinctive pattern comes first, the whole group will seem insignificant. Hence, it makes sense to place the important ones that carry more of an influence first.

The last pattern of the group is also unique because they are challenging to apply and implement, or it is a distinctive pattern that occurs less frequently than others. If there is such a pattern in the first or second place, it will be challenging to continue with the following pattern.

Accordingly, the first and last patterns of the group are distinctive. On the other hand, the second pattern is less peculiar and versatile. In most cases, the order of the second pattern is decided after the first and third are determined. The second pattern is not introductory, nor is it too difficult or exceptional; it is just a typical pattern. However, it may be a pattern that is a bit deeper than the first or a pattern that comes later in terms of time or experience than the first pattern.

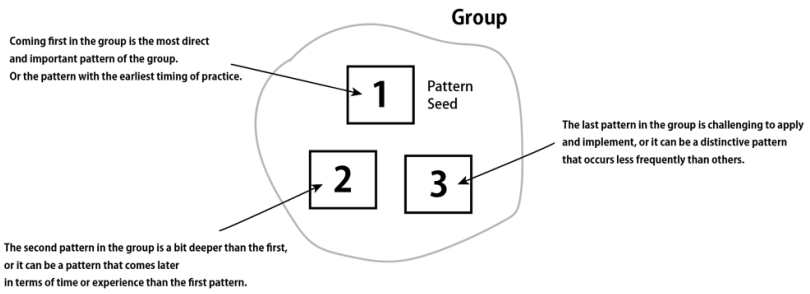

Figure 10: Order of patterns in a group

Also, from a broader perspective, some points need to be considered at the beginning and end of a category (Figure 11). At the beginning of a category, it is ideal to have an introductory pattern with primary contents since this is the first pattern that the reader will read in that category. If the pattern is suddenly thrown in a random direction from the beginning, the reader will feel confused. The first pattern to be read should be a straightforward pattern that feels like a "gate" to the upcoming patterns. Therefore, think about what the first pattern should be and change the order of the groups so the pattern can be read as an introduction if necessary.

Then, the last pattern in the category leaves a strong impression after reading the patterns. As a result, the last pattern of the category must be a pattern that opens up to the future or heartwarming. The third pattern in the group is either a pattern that is difficult to apply or a distinctive pattern that occurs less frequently than the others. However, for the last group in the category, there should be more emphasis on if the category opens up to the future or if it is heartwarming.

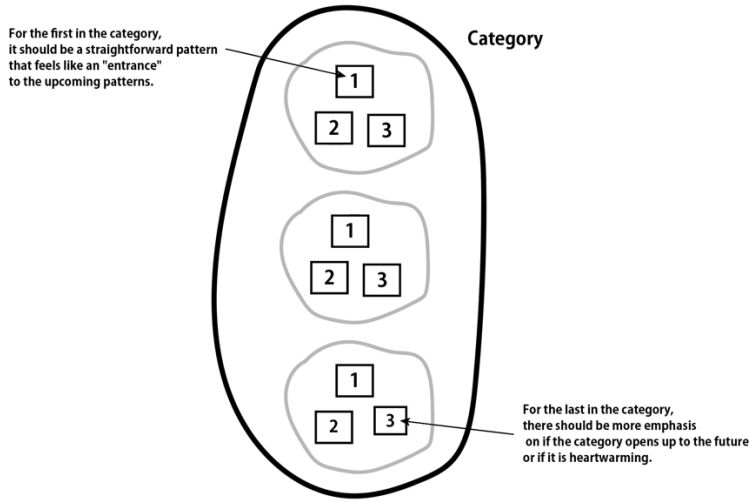

Figure 11: Patterns to place at the beginning and end of categories

4.5 Arrange the Number of Groups in Each Category and the Number of Patterns in Each Group

While considering the order within the groups described above, you will also consider moving patterns between groups to create precisely three patterns within a group. By adjusting the *grouping criteria*, you try to see if you can get precisely three.

If there are only one or two things that seem close, it may be because the meaning of similarity is too narrow or limited, so this is where the criteria can be loosened. If you broaden the criteria a little or look at the points from a different perspective, you might find other patterns that fit into this group.

Also, if there are four or five patterns, you can review the criteria or view the patterns from a different perspective to see which three patterns are the closest or similar.

Usually, you first look at other *groups* (patterns) within that category, but occasionally you take a moment to see if another category would better fit the pattern. Doing so will enable us to see if a pattern that was placed in another category from a completely different perspective will fit perfectly into this group. As you make these adjustments, you can create groups of three patterns each.

Furthermore, you look at the number of groups in the overall category and figure out the correct number of groups. You usually try to have the same number of groups in each category. In other words, you define the categories so that you have the same number of groups. It is a process of adjusting from inside the group (patterns within the group) and outside the group (categories) to make the patterns fit like a glove.

Since the number of patterns (pattern seeds) you have now is not necessarily a multiple of three, you must look at the incomplete groups, find the missing piece of the patterns, and fit three patterns neatly from a bottom-up approach. If there are not enough patterns, you will try to determine if there were any left out from the mining interview or if two patterns can be made into three. For example, a broad pattern can sometimes be divided into two patterns with different points of emphasis by making the pattern a little more specific. Or it may be possible to create another pattern by combining two similar patterns that share the same qualities.

Also, even if there are enough patterns, if you look at the system and feel that something is missing, you can look back at the mining dialogue and your experiences to see if there are any stories that correspond to that feeling. You can usually find the missing piece among the context obtained by the

mining interviews but were not used or compiled elsewhere. If you feel that something important is missing, you will conduct additional mining interviews. As a result, you can align the elements that should be there.

On the other hand, if there are too many patterns, or if they cannot be placed anywhere in the thoroughly thought-out system, there is a possibility that the patterns can be combined, or that they are weak, to begin with. So, the first thing to do is think about whether it can be integrated into some other pattern. For example, if the content of the pattern is specific enough, it can often be an action of a pattern. Or, if you broaden the context of the two patterns, you may make them into a combined pattern.

If, even after careful consideration, the pattern does not fit in well, and since forcing it in a group result in downgrading the pattern, there is also a choice to leave the pattern as it is. (This approach is different from the KJ method)

4.6 Check the Pattern Language

Once the system is complete, try to explain the contents orally and reconsider any part that does not make sense or does not fit well. Then, explain how the above patterns can be achieved by relating the patterns to each other, creating a pattern network. If necessary, correct the details that feel are not in the right place. This explanation can be done alone as a self-check with other project members or people outside the project.

Specifically, try to explain like so, "To accomplish the goal of this pattern language, these three major factors (categories) are important: *A*, *B*, and *C*. To do *A*, it is important to act on *A-1*, *A-2*, and *A-3* (groups). For doing *A-1*, it is best to do *A-1-1*, *A-1-2*, and *A-1-3* (patterns)."

If the system is not well organized, some questions may come up, such as "Why is the category, group, or pattern here?" If this happens, it means that the part needs to be revisited. Sometimes the revisions are limited to that part, but other times it may affect the entire pattern language. In any case, it is necessary to read the categories, groups, and patterns repeatedly and make the needed corrections until you are satisfied with the perfect pattern language.

4.7 Rewrite the Individual Pattern Outlines Based on the Systematization Results

Once the systematization is complete, the meaning of each pattern will change depending on its position in the overall system, so the summary should be rewritten accordingly. At this point, be careful not to rewrite the summary from an objective point of view. Also, try to remember the original mining story, and write it in a way according to the patterns' position in the system.

5. Discussion: Why *Three*?

We divide the whole into three categories or a group of three patterns because *three* is the correct number to organize the whole system beautifully. With two, it is not possible to incorporate a variety of perspectives. On the other hand, with four, it can be divided into two and two, and there may be some axis that will make it more complex in structure. It is possible to have four or five categories, but the more categories there are, the harder it is to grasp the whole, so it is best to keep it to three.

Patterns are grouped in threes because it has just the right amount of variety and complexity. An even number can be divided into halves, so it can still contain structure, but three can be made into a unit that is not *divisible* like an even number. Moreover, there is a dynamic image, known as the three-body problem, where chaos arises when there are three relations.

In any case, deciding on the number three and creating a system to match it is practical knowledge. We can focus our thoughts on rearranging the patterns into three groups and the groups into three categories by having a fixed number. Without this limitation, both the content and the framework can be highly changeable, and there will be no cohesion. By having such guidelines, we can avoid having too many or too few contents and create a system that covers the whole pattern language evenly.

Furthermore, a complex structure with different numbers for different groups is more difficult for the person trying to use and understand the pattern language. For these reasons, we create and systemize a structure that divides into three.

6. Conclusion

In this paper, we have introduced a method of systematization of pattern language, which has never been discussed before. We have developed and refined our research and practice. We hope that the contents of this paper will be helpful to those who create pattern languages in the future.

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