

Usability Pattern Languages: the "Language" Aspect

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Abstract:



The pattern language concept, adapted from building architecture and detailed software design, has recently been applied to HCI by a number of researchers. We argue that the "language" aspect of pattern languages is critical and outline thirteen research efforts in HCI patterns. Many pattern collections have broad scopes, and we argue that this results in patterns which are not as interdependent as a narrow scope would allow. The argument is illustrated with our Planet pattern language, which helps developers reuse knowledge for internationalised software. The narrow scope, namely a focus on the needs of internationalised users, allows us to produce interdependent patterns which range in abstraction level, from organisational process to high-level specification to detailed software design. Thus, the language supports a generative, interdisciplinary, approach to reusing knowledge in HCI.

Patterns for HCI have recently been developed by a significant number of researchers (e.g. Borchers, 1999; Sutcliffe, 1999; Tidwell, 1998). There are now several pattern collections which

are intended to improve reuse of human-computer interaction. Yet, there continues to be a question about the efficacy of the approach. Some patterns are obvious and others are unproven speculations which defy the term "pattern". It is often difficult to see how a pattern collection could offer true benefits to a practitioner. Our view is that the critical notion of "language" in "pattern language" is all too often overlooked. In this paper, we explain what constitutes a true pattern language and argue that it is pattern languages, and not "pattern collections" or isolated patterns, which will provide the greatest long-term benefits to HCI.

In this paper, we discuss what is meant by patterns and pattern languages, and explain how pattern languages can benefit HCI (Section 2). We argue that a tight focus facilitates a well-integrated set of patterns, and observe that few present approaches do have narrow scopes (Section 3). We then describe the Planet pattern language for software internationalisation, which demonstrates the relationship between scope and language coherence (Section 4).

2. Background: Patterns and Pattern Languages

The design pattern approach was originally developed for town planning and building architecture. [Christopher Alexander](#), an architect who was disaffected with modern architectural practice, argued that a rigid design process had led to the prevalence of impractical solutions. He drew inspiration from ancient cultures, which had evolved buildings and town plans over generations (Alexander, 1964), and noticed there were recurring features, or "patterns". With his colleagues, he published 253 patterns for town planning and building architecture (Alexander, 1977), for reuse in new projects.

A pattern has defined fields, including Context, Problem, Forces, and Solution. A pattern is used in a certain design Context, and considers a recurring design Problem in this context. It focuses on the Forces which confront the designer, before describing a Solution--a proposed approach to the situation which resolves the tensions among forces. Consider Alexander's **A Place to**

Wait pattern

(Alexander, 1977). The context is any situation where people are waiting for something, such as a doctor's surgery. Two forces conflict: (a) patients must be present when the doctor is ready, but (b) the timing of this event is uncertain, leading to an anxious situation. A suggested solution is to draw in people who are

not

waiting. One hospital created a neighbourhood playground which doubled as a children's

waiting area, so that the young patients felt at ease before their consultation.

An individual pattern can contribute to increased reuse, but the biggest gains arise when patterns are carefully combined. Once the solution to a pattern has been applied, a new context arises in which more detailed problems require solution. Further patterns can be invoked to capture the problem-solving processes inherent in this new context. A *pattern language* is formed when a collection of patterns is arranged into a network of interdependent patterns, especially where higher-level patterns yield contexts which are resolved by more detailed patterns. This allows a designer to apply the pattern language generatively, beginning with a specific context, and working through all relevant patterns to generate the design. In *A Place to Wait*, the essential solution is to mix people who are waiting with others who are not waiting, and also to provide a quiet place where people can retreat while waiting. Alexander suggests several ways to achieve the first goal, by pointing to other patterns in the language, e.g. *Street Cafe*. The propagative nature explains why Alexander's patterns vary so widely in their granularity. The language begins with the distribution of towns (*City Country Fingers*), works into town-planning (*Ring Roads*) and building architecture (*Staircase as a Stage*), and finishes at the level of detailed construction (*Paving with Cracks Between the Stones*).

To appreciate the importance of a *pattern language*, it is necessary to comprehend the subjective basis of pattern languages. Far from being the objective and exhaustive catalogue of ideas they may initially seem, patterns are based heavily on an underlying set of values. They explain how forces are identified and resolved according to certain principles; in doing so, they are encapsulating a particular approach. Alexander identified, valued, and discarded patterns in a process which embodied his own architectural philosophy (Kerth, 1997).

A language should generate artifacts aligned to the philosophy on which the language is based; the artifact does not have to be derived directly from the philosophy. Gabriel (1996) has likened this phenomenon to that of a tennis player learning to hit a ball. The goal is to hit smoothly and powerfully, but the instruction is to aim for a point just beyond the ball. There is no obvious connection between the goal and the instruction. Yet, following the instruction achieves the goal.

To achieve the goal of a usable system, the typical HCI approach is to advocate the use of guidelines. However, such guidelines can conflict with each other, and designers need concrete examples illustrating how to resolve these conflicts. Patterns illustrate how conflicting forces can be resolved in typical design settings. Furthermore, guidelines generally have no inter-relational structure. In contrast, pattern languages aid the designer by beginning with high-level problems and working down to detailed problems. An individual pattern cannot be used in this way.

Real-life projects warrant a tightly-related set of patterns, which work together to create a consistent design.

The following scenario explains how a good pattern language can work in practice. The designer begins a program design by applying pattern A. This leads to a lower-level design problem, which pattern A notes is solved by one of the patterns B or C. The designers settle on C because it fits their needs. Applying pattern C to the existing design is straightforward because pattern C assumes pattern A has been applied where necessary. The design is coded, and a change request arrives after a few months. The designers realise pattern D would be helpful, and pattern D is again straightforward to implement because it is based on the same concepts as the previous patterns.

As long ago as 1975, Fred Brooks declared that conceptual integrity was a key issue in system design (Brooks, 1995). By applying closely-related patterns which propagate from one to another, it is possible to achieve this unity of approach.

A good example of a well-integrated pattern language for HCI is provided by Bradac (1998). The language has a very specific focus: design of GUI-based forms. The first of five patterns, Subform, suggests breaking a form into subforms. This is a good example of a straightforward prescriptive pattern, and it forms the groundwork for the rest of the language. The other patterns provide guidance on the decomposition of the form, and the dynamic communication mechanisms between the various components. Alternative Subforms suggests using state data to produce an appropriate subform. For example, a user who selects a Home Country of USA needs a particular address format, while a user who selects Australia requires a different format. The Address subform then depends on the Home Country field. But this opens up a new problem: what if the user alters Home Country? The Subform Selection pattern shows how to handle it with a polling mechanism. Subsequent patterns offer further resolution.

A designer can approach Bradac et al.'s language with a very specific goal in mind: to design a form-style window. The patterns then take the designer through the various decisions which must be made. This makes the language *generative*. Furthermore, a common set of principles lies beneath the patterns. These are implicit and, in this language, relate to the usual high-level principles associated with GUIs (e.g. Recognise Not Recall). The patterns work together to produce systems which adhere to these principles. It would be nonsensical to produce a collection of patterns which are based on incompatible principles.

Pattern languages have mainly been the domain of the architectural software design community. While attributes such as maintainability and reliability are considered, usability is not often a primary concern. However, unlike a computer program, user reactions cannot be accurately predicted. Usability patterns can document features which worked for users, reducing the costly trial-and-error cycle.

3. Patterns in HCI: Current Research Efforts

In analysing existing research efforts, it is helpful to categorise approaches according to three dimensions:

- **Level of Abstraction.** Possibilities include patterns of user-interfaces, of tasks, of users, and so on.
- **Target Medium.** Possibilities include conventional GUIs, websites, handhelds.
- **Specialised Requirements.** Possibilities include specialised application domains (banking), specialised user characteristics (blind users), specialised software qualities (safety-critical systems)

Several HCI pattern collections have been developed in recent years, in parallel to the present work. Table 1 summarises the best-known contributions, inferring where each lies according to the classification above. In each case, the descriptions of the dimensions have necessarily been simplified.

Approach	Level of Abstraction	Target Medium	Specialised Requirements
Tidwell (1998): Interaction Design Multiple Patterns	Multiple Patterns	GUIs	None
Brighton Usability Group (2001): System Patterns	Multiple Patterns	GUIs	None
Van Welie (2000): A Multiple Pattern GUI Application	Multiple Patterns	GUIs	None
Coram (1996): Experience and single GUI Applications	Multiple Patterns	GUIs	None
Wake (1998): Pattern Multiple Interactive GUI Applications	Multiple Patterns	GUIs	None
Borchers (1999): Interaction Design Multiple Patterns	Multiple Patterns	GUIs	None
Cybulski (2000): Multiple Patterns	Multiple Patterns	GUIs	None
Bradac (1998): Pattern Multiple Forms	Multiple Patterns	GUIs	None
Perzel (1999): Usability Multiple Patterns	Multiple Patterns	GUIs	None
Riehle (1995): Tool Multiple Patterns	Multiple Patterns	GUIs	None
(Breedvelt, 1997): Reasonable Structure	Multiple Patterns	GUIs	None
(Stimmel, 1999): Pattern Development	Multiple Patterns	GUIs	None
Mahemoff (1999), Mahemoff (2001) Patterns	Multiple Patterns	GUIs	None

Table 1: A Survey of Recent HCI Pattern Collections

The first five approaches (Tidwell, Brighton Usability Group, Van Welie and Traetteberg, Coram and Lee, Wake) address mostly user-interface issues for desktop applications. Borchers' approach devotes more attention to the application domain. The next few approaches (Cybulski

and Linden, Bradac and Fletcher, Perzel and Kane, Riehle) look at particular types of systems, i.e. multimedia, software with forms, websites, software for manipulating artifacts. The two approaches other than ours (Breedvelt-Schouten et al., Stimmel) relate to various systems, but feature different levels of abstraction: task models, development process.

At present, few pattern collections are tightly constrained to their target medium or specialised requirements. Many have a target medium of GUI applications, and occasional evidence that websites have been considered. However, this is still a very broad category--while the principles of design for GUIs are well-understood, they do vary across platforms. Collections of patterns which are not tightly constrained in some way are unlikely to produce an end product which is conceptually self-consistent. In terms of specialised requirements, few approaches constrain their scope.

In aiming for a pattern language, the most effective approach is to constrain the scope of the language. A tight scope implies a more homogeneous set of example applications from which patterns are derived. More homogeneous applications will share similar design features, and these features will work better with other features, even if the other features belong to different systems.

There is certainly a benefit in capturing successful design concepts, whatever the format. A large catalogue of HCI patterns would be an excellent resource for students and practitioners alike. But while reusable knowledge repositories are developed, it is important to recognise the importance of the language aspect. A pattern language makes generative design possible and contributes significantly to the conceptual integrity of the end product. Furthermore, it is possible that constraining scope in some areas may enable us to expand scope in other areas. We are particularly interested in expanding the levels of abstraction covered by a pattern language. By constraining the target medium or specialised requirements, it should be possible to create patterns which relate high-level concepts to detailed software. Perhaps the closest approach to our work is Borchers' patterns. In this interdisciplinary approach, there are separate languages for software patterns, HCI patterns, and domain-specific patterns--musical patterns in Borchers' example. Our approach differs in that all patterns focus on our area of interest--in this case, software internationalisation. The patterns are highly inter-dependent--they are intended to work effectively with each other, and would have little use in isolation.

Pattern languages for HCI may not immediately gain widespread acceptance. They require more effort to construct than general-purpose HCI pattern collections, as each pattern must be consistent with the others, and all must work towards common goals. If they address situations with limited scope, they will not be as broadly applicable. Yet, a prerequisite to a

"general-purpose" HCI language is a series of highly-focused pattern languages. Such languages would also be valuable to practitioners working in the target area.

4. Planet: An Example of an HCI Pattern Language

Planet is our attempt to demonstrate that, by constraining the scope, a rich set of inter-pattern relationships can be captured. The language has a specialised requirement: software internationalisation. This tight focus has enabled us to look at a variety of target media and, more importantly, to address multiple levels of abstraction. The patterns were created by studying the issues involved in software internationalisation and studying successful features of internationalised systems. We have documented the language and a sample application, Critique, which realises many of the patterns (Mahemoff, 2001).

As mentioned, a pattern language is based on an underlying set of principles. Although principles often remain implicit, we now state those of Planet's to illustrate our point.

- **Developers should Acknowledge Cultural Diversity.** Cultures differ in obvious areas such as units of measurement as well as in more subtle areas such as social rules.
- **A Universal Version is Unrealistic.** Instead of seeing cultural diversity as a barrier, designers can exploit the fact that people will have a particularly strong connection with features targeting their own needs.
- **Every Person has Individual Needs.** Cultural differences are important only to the extent they establish all the parameters of the software; individuals should still be free to choose their own values of these parameters.
- **Developers should Reuse Knowledge about Users.** Since the process of learning about foreign cultures is difficult and time-consuming, reusing information saves time and money.
- **Enable Then Localise.** For optimal efficiency, the core software components should not have to be duplicated.

As Figure 1 shows, the Planet language consists of Patterns at three levels of abstraction:

- **Organisational process patterns** help an organisation track information about the cultures their software supports.
- **High-Level Specification Patterns** guide decisions regarding functionality, user-interfaces, and configuration of preferences.
- **Detailed Design Patterns** support detailed software design, at a similar level to

conventional software design patterns.

The patterns are structured so that they can be used generatively: high-level patterns lead to more detailed patterns. This large variation in abstraction level is unusual for an HCI language, but has precursors in work such as Alexander's patterns (Alexander, 1977).

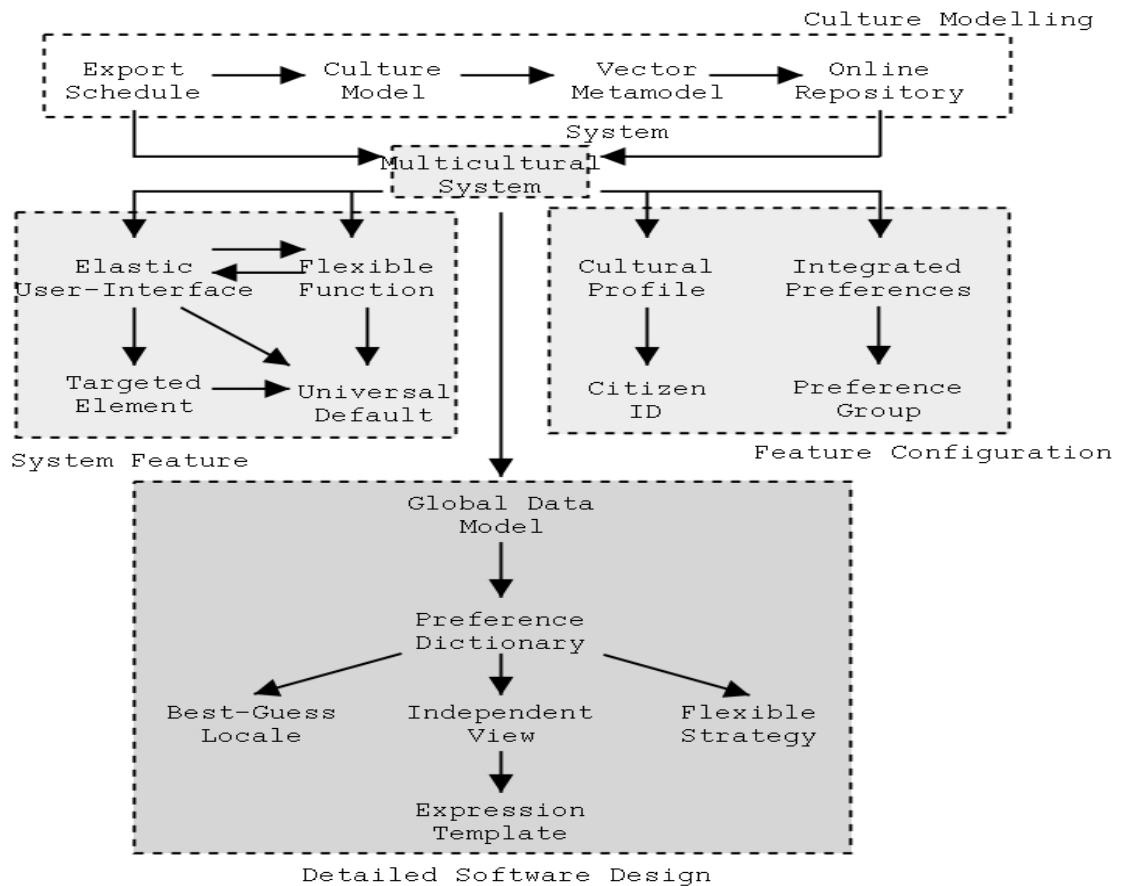


Figure 1: Map of Planet Pattern Language, showing three layers: organisational patterns, high-level specification patterns, detailed design patterns.

In this section, we show the core solution of each pattern. References to other patterns are shown in Typewriter font. First, the organisational patterns:

- **Export Schedule** Produce a schedule which indicates *when* each target culture will be

supported, and
important

how

it is

to support each target culture.

- **Culture Model** Construct models of cultures which are relevant to your projects. When you discover new information about a culture, add it to the culture model.
- **Vector Metamodel** Determine the dimensions of cultures that interest you, and characterise each CultureModel as a vector with a value for each dimension.
- **Online Repository** Create an online repository accessible organisation-wide. Use CultureModels all from the same VectorMetamodel.

Next are the high-level specification patterns. These begin with a meta-pattern, , which serves to structure the overall language:

- **Flexible Function** When you generate a new function, check if it is culture-specific, and if so, refine it to meet the needs of your target cultures.
- **Elastic User-Interface** Design the overall structure for the user-interface flexibly, so that UI elements can subsequently be redefined and rearranged without massive design changes.
- **Targeted Element** For each abstract element contained in the ElasticUI specification, provide an instantiation targeted to each culture in the ExportSchedule.
- **Universal Default** For each culture-dependent feature in the target system, make a default which is universally meaningful.
- **Cultural Profile** Provide a default profile for each target culture, a profile which specifies the value of each culture-dependent feature.
- **Citizen ID** Determine the user's culture on first use and permit this preference to persist. Select the CulturalProfile based on the user's Citizen ID.
- **Integrated Preferences** Integrate culture-related preferences with general preferences.
- **Preference Group** Group related preferences, so the user must make only one choice to set all preferences in the group to logically-related values.

A small set of patterns can be used to drive the detailed design for systems specified according to the patterns above. This set of patterns constitutes the detailed software patterns of Planet:

- **Global Data Model** Encapsulate data required to support all cultures in a global data model, independent of the user-interface.
- **Preference Dictionary** Encapsulate all of the user's current preferences, whether culture-specific or not, in a single dictionary (i.e. key-value pairs) class.
- **Best-Guess Locale** Create a "global culture" PreferenceDictionary object which contains UniversalDefaults. For each supported culture mentioned in your ExportSchedule, create a PreferenceDictionary object to override the global PreferenceDictionary.

- **Independent View** Create one or more views of the GlobalDataModel, and store the user's preferred view within the PreferenceDictionary.
- **Expression Template** Encapsulate each culture-specific expression in a template string. Store the template string in the culture's PreferenceDictionary.
- **Flexible Strategy** Create an abstract class which declares the interface for the algorithm, then create culture-specific implementations of this class (based on Gamma et al.'s (1995) Strategy pattern).

In this section, a sketch is provided for one pattern in each of the three levels of abstraction.

Organisational Pattern: Online Repository

Context:	You have begun to maintain Culture Models according to a selected Vector Me
Problem:	How can a collection of culture models be organised to be useful for s
Forces:	
-	Organisation-wide Culture Models avoid duplication; it is feasible and desirable to transfer informat
-	Information about cultures is often discovered in physically distant locations.
-	If developers cannot access models quickly and easily, the information will be ignored.
-	If developers cannot update models easily, the information will lose accuracy over time.
-	Developers may wish to look up a specific Culture Model, but they may also wish to explore inform

Solution:	Create an online repository for the entire organisation. Compose it of Cult
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The following guidelines **make** it easy to information in the repository:

- Provide browsing facilities which present each culture and factor.
- Provide facilities to search the Culture Models.
- Link from one model to another if it helps to demonstrate a point of similarity or difference.
- Link to the original artifacts if they are online, or identify sources if they are not.

The following guidelines **update** it easy to the repository:

- Facilitate discussion among contributors, e.g. via a mailing list or within the repository system.
- Make one individual responsible for managing the overall repository, promoting the repository with
- Make one person responsible for maintaining each Culture Model.

Examples

- Fernandes (1995) contains some tables showing factors versus culture. However, the text stops sh
- Ito and Nakakoji (1996) have prototyped a system for retrieving culture-specific details.

Resulting Context:	The repository enables developers to easily access a corpus of culture-specific
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High-Level Specification Pattern: Cultural Profile

Context:	You are designing a MulticulturalSystem.
Problem:	How do you handle the configuration of features which are culture-specific
Forces:	

- A Multicultural System offers many choices because each feature has several culture-specific variables.
- Most users want to begin working on a product right away, rather than exert effort configuring it.
- Users may not be capable of specifying the appropriate settings for some variables, even in their own language.

Solution:	Provide a default profile for each target culture, as well as a profile which specifies the
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An additional benefit is that users can dynamically switch between cultures. This may be of use when two

Examples:	The Locale library in Linux defines several culture-related options, e.g. language
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Many websites of multinational companies produce different pages depending on the country of origin (e.g.

Resulting Context:	A number of cultural profiles are available. Citizen ID provides a mechanism for
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Detailed Design Pattern: Preference Dictionary

Context:	You have created the Global Data Model.
Problem:	There are many preferences. How do you track those parameters specific to a user?
Forces:	

- Culture Models will change as developers learn more and as the actual cultures themselves undergo
- The user can tailor preferences to their own selection, so culture alone is an inadequate specification
- This information will be used by many modules. It should be as compact as possible.

Solution:	Encapsulate all of the user's current preferences, whether culture-specific or
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Keys for the preferenceBundle dictionary:

- BackgroundColor
- FontFamily
- MessageBundle
- EvaluationBundle
- NumberFormat

(The preferenceBundle object is a member of the ResourceBundle class)

Figure 2:	PreferenceDictionary	Example: Critique's preferenceBundle
has key-value pairs for		all user-changeable parameters, culture-specific or not.

Examples:

- Java's ResourceBundle class is used by Critique for all preferences. The Preferences Dialog (Pref
- In Java, the default values are also specified in the ResourceBundle. Note there is an EvaluationB

Resulting Context:	You have declared the	parameters by which your software will vary. Now you n
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5. Discussion

HCI patterns research is still relatively new, and researchers have been debating the basic concepts of patterns. Many existing pattern collections do not exploit the "language" property of patterns to a large degree. Pattern languages, while they are less simple to produce, provide a way to achieve the design goal of conceptual integrity, thereby producing a more consistent user interface, and better support for reuse and maintainability.

Planet demonstrates what we mean by a pattern language. To create a tightly-connected language, we constrained our scope to focus specifically on supporting international audiences. The language is based on an explicit set of principles, with the patterns guiding the developer in a direction which adheres to these principles. For instance, the patterns guiding preference configuration show how to consider cultural factors ("Designers should Acknowledge Cultural Diversity"), while keeping the settings flexible ("Every Person is an Individual"). The narrow scope means that a broad range of issues could be covered. Organisational patterns facilitate the ongoing process of learning about cultures and documenting them. Once an organisation has identified its target cultures and sufficiently investigated their needs, high-level specification can proceed. The patterns at this next level address software functionality, user-interface design, and configuration of preferences. Detailed design patterns follow from the high-level specification.

Pattern languages fulfill many of the goals of HCI. Because they can cross levels of abstraction, they can facilitate a more integrated, interdisciplinary approach. This interdisciplinary approach is also evident in their concrete nature, which makes them approachable for non-HCI

specialists, including end-users.

Pattern languages also support an iterative design process: a well-integrated language allows software to be developed with some patterns, then improved with more patterns from the language at a later date. The compromise is a more limited scope; the patterns are not applicable to all situations. Whether a more general language can be created which still has a strong sense of connection among patterns is an open research topic. In the meantime, most organisations create applications which are very similar to one another. They could benefit by capturing their own patterns at differing levels of abstraction, and using them as a basis for interdisciplinary work and ongoing process improvement.

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