

From Pace Layering to Resilience Theory: The Complex Implications of Tagging for Information Architecture

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Abstract

This paper uses theories of complexity, pace layering and resilience to address the question of tagging and folksonomies, and their influence on the practice of information architecture. User-centered tagging systems such as *Flickr* and *del.icio.us* have triggered diverse responses, both within and outside the community of information studies, because they differ so sharply from many standard approaches. To some, pace layering theory suggests that user-centered tagging systems can supplement traditional IA practices, rather than replacing them. In this paper, we suggest that pace layering theory, when combined with complexity theory and resilience theory as practiced in ecological studies, can provide a model of interaction between folksonomies and conventional information architecture that is based on the complex interactions of productive revolt that characterize adaptive systems. This model can help us to define a broader role for information architecture, in which we combine research and practice to develop a working sense of productive change and development in information environments.

Introduction

What are the long-term implications of tagging, folksonomies, and other user-centric information structures for the development of information architecture (IA) theory and practice? Collaborative tagging systems continue to gain prominence on the Web, and information architects have not yet decided how to respond. On the one hand, the presence and popularity of systems like *Flickr*, *del.icio.us*, and *Technorati* validate a basic message of information architecture: good website design rests on certain principles, such as “findability,” which can best be discovered by carefully consulting users and determining their needs (Morville, 2005; Reiss, 2000; Rosenfeld & Morville, 2002; Wodtke, 2003). On the other hand, user-based tagging systems provide none of the features that information architects believe essential to creating robust architectures, such as rigorous, carefully-designed hierarchies, structured metadata, faceted browsing schemes or controlled vocabularies. The popularity and supposed benefits of tagging in systems like *Flickr* and *del.icio.us* suggests that these value-added features are unnecessary, and so, by extension, are information architects.

We suggest that there is a tension between collaborative tagging systems and established IA conventions, and that this tension is potentially a source of strength and future innovation. Rather than resolving this stability into a glib resolution, we will draw on

research in various fields to enrich the vocabularies and strategies available to information architects as they grapple with this question over the long term. To reach this aim, we begin with the use of the pace layering theory to establish the relationship of tagging to IA (Morville 2005). We then use complexity theory to enrich the concept of user-centered tagging, and introduce resilience theory to enrich the concept of pace layering.

Pace layering and tagging systems

Pace layering theory provides a useful conceptual tool for understanding the complex nature of the systems that information architects design. As first articulated by Stewart Brand, pace layering theory suggests that buildings can be divided into different “layers,” each defined by the speed by which it changes: while the structure, for instance, changes very slowly, the skin, or exterior surface, changes more rapidly, and the interior layout and the position of furniture change more rapidly still (Brand 1994, 13). In addition, a central premise of pace layering is that different rates of change are beneficial for the overall development of a complex system: the fast layers propose and innovate; the slow layers absorb and stabilize (Brand 1999).

Classifying the different elements of building design according to their rates of change enables the architect to create sensible solutions: “Thinking about buildings in this time-laden way is very practical. As a designer, you avoid such classic mistakes as solving a five-minute problem with a 40-year solution, or vice versa” (cited in Brand 1994, 17). Later, in *The Clock of the Long Now*, Brand (1999) used pace layering to develop a broad theory of change and evolution in human societies. Pace layering has also found application in ecology and environmental studies (Holling et al., 2002), an area we will return to later in this paper.

Information architects have adapted pace layering to conceptualize different aspects of their practice (Figure 1). For example, Morville (2001) used a layered framework to differentiate the components of an information architecture, and Garrett (2003) used a similar approach to characterize the elements of user experience. Several information architects have noted that these and other frameworks are based, implicitly and explicitly, on a pace layering model (Melzer 2005; Merholz 2002).

In *Ambient Findability* (2005), Morville uses pace layering to suggest that user-centered tagging systems can supplement traditional IA practices, rather than replacing them. Morville argues that user tagging, in all its messiness, speed and vitality, constitutes a fast layer of information architecture, one which will gradually affect the underlying structures of websites, which change and slower and more controlled rates: “over time, the lessons learned at the top are passed down, embedded into the more enduring layers of social and semantic infrastructure” (Morville 2005, 141).

	Architectural Components	The Iceberg of IA	Elements of User Experience	Planes of User Experience
<div style="display: flex; align-items: center;"> <div style="margin-right: 10px;">Fast</div> <div style="border-left: 1px solid black; border-right: 1px solid black; height: 100px; margin-right: 10px;"></div> <div style="margin-right: 10px;">↑</div> </div>	Content, services, interface	Interface	Visual design	Surface
	Adaptive finding tools	Wireframes Blueprints	Interface design Navigation design Information design	Skeleton
	Controlled vocabulary	Metadata Classification schemes Thesauri	Interaction design Information architecture	Structure
	Enabling technologies	IA strategies Project plans	Functional specifications Content requirements	Scope
	Embedded navigation system	Users (needs, behaviors) Content (structure, meaning) Context (culture, technology)	User needs Site objectives	Strategy
	Faceted classification schemes			
<div style="display: flex; align-items: center;"> <div style="margin-right: 10px;">Slow</div> </div>				

Figure 1: Information architecture pace layering models. Each model has multiple layers, with fast layers on top and slow layers at bottom. The models are: architectural components (Morville 2001); the Iceberg of IA (Morville 2000); elements of user experience (Garrett 2003); planes of user experience (Garrett 2003).

This genial view suggests that information architects can get on with their slower, deeper work, while letting user-centered tagging spin on the surface. If anything of value surfaces in these user tags, the value will gradually seep down to the lower layers. To some extent, Brand’s original diagram (Figure 2) of the pace layering phenomenon supports this view:

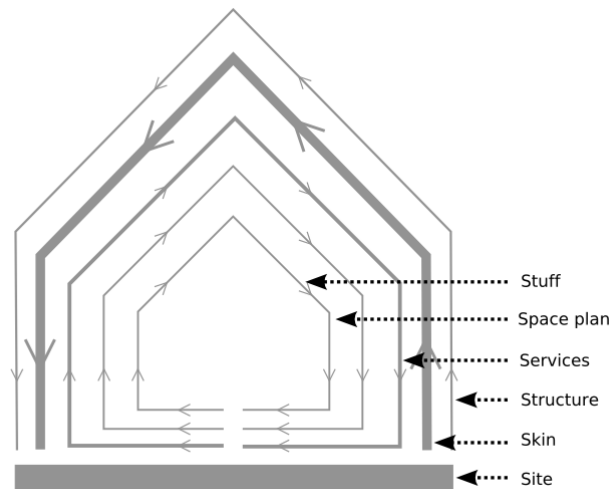


Figure 2: Pace layering in buildings. Adapted from *How buildings learn: What happens after they’re built* (Brand 1994).

In this diagram, the lines run parallel to each other, with the arrows suggesting movement solely within the layers; there is little visual suggestion of interaction between the layers. IA pace layering diagrams also rely heavily on parallel planes, which change at different

rates but never appear to meet. But Brand's caption to his initial diagram suggests the importance of friction between the layers: "Because of the different rates of change of its components, a building is always tearing itself apart" (Brand 1994, 13).

Brand implies that destructive conflict between layers does not arise solely from avoidable mistakes, but from inevitable conflict arising from different rates of change. If this is true, then pace layering theory does not provide a way of producing successful, long-lasting website designs: instead, it provides a thoughtful and compelling reason why all web designs will eventually collapse under certain conditions. In other words, a critical yet mostly unexplored aspect of pace layering theory is not the separation of the layers, but the consequences of their interactions.

We seem, then, to have a choice between an optimistic and a pessimistic interpretation of tagging systems and their effect on information architecture. Both, however, cry out for better insights into what user-centered tagging does, and how pace layering actually works. The remainder of the paper will address both.

From *laissez-faire* librarianship to complexity theory

Collaborative tagging systems do not rely on indexers to assign controlled vocabulary terms to the subject content of websites. Instead, they enable individual users to apply their own terms, and to make their tags consistent with those of other users. A tagging system like *del.icio.us*, as shown in Figure 3, enables a user both to view his or her tags as clouds, and to connect to other users who have linked to preferred sites:

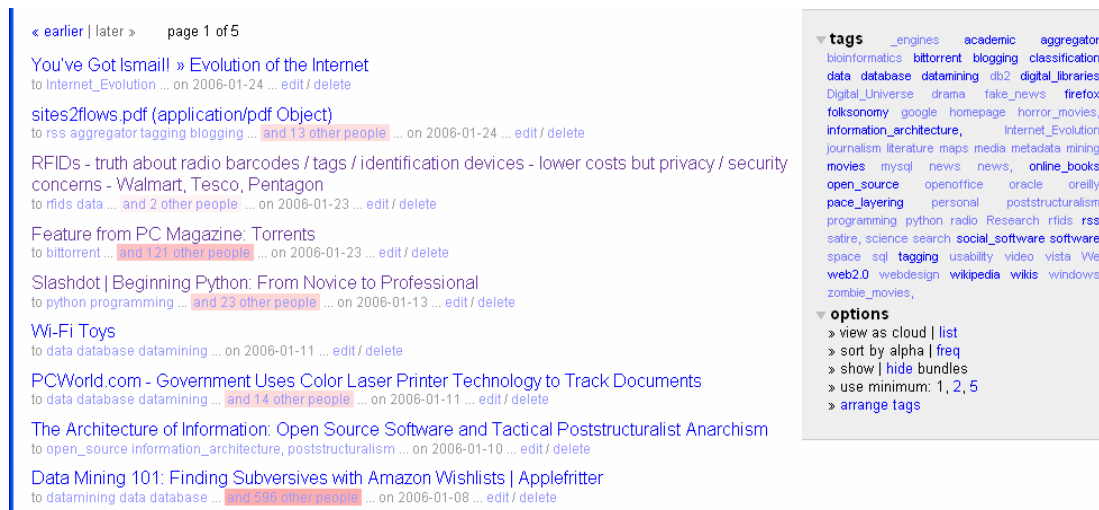


Figure 3: Tagging in del.icio.us.

At the heart of folksonomy efforts like these lies a set of assumptions that have long held enormous cachet in Web circles, at least since Google's PageRank revolutionized search engine performance:

- If you get enough people doing what they like—linking, tagging, sharing or subscribing—interesting and useful patterns emerge;

- These patterns get more useful and more interesting as more people join in to do what they like;
- Systems that exploit these patterns can scale to larger sizes in ways that traditional information systems, such as library catalogues, cannot;
- Systems with fewer rules and constraints are more likely to obtain widespread adoption and more likely to generate beneficial emergent patterns.

By subscribing to these assumptions, collaborative tagging seems to have found a kind of perpetual motion: by practicing a *laissez-faire* form of web architecture, an information provider can simply let people tag as they wish, and the connections between tags will only increase in sharpness, utility, and useful complexity as more and more people generate more and more tags.

Much of the enthusiasm behind collaborative tagging relies implicitly on theories of complexity and emergence, theories that have acquired considerable influence in biology, computer science, sociology and economics, and which have entered the mainstream consciousness through such influential works as Mitchell Waldrop's *Complexity: The Emerging Science at the Edge of Order and Chaos* (1992) and Steven Johnson's *Emergence: The Connected Lives of Ants, Brains, Cities, and Software* (2001). Waldrop defines complexity theory as the study of "complex, self-organizing, adaptive systems" that consist of independent agents interacting with each other in such rich and diverse ways that they are capable of spontaneous self-organization (1992, 11). Johnson defines emergent systems as bottom-up configurations which "solve problems by drawing on masses of relatively stupid elements, rather than a single, intelligent 'executive branch.' ... In these systems, agents residing on one scale start producing behavior that lies one scale above them: ants create colonies; urbanites create neighborhoods; simple pattern-recognition software learns how to recommend new books" (2001, 18).

A pivotal premise of user-centered tagging is that many individual gestures of description and connection will self-organize into patterns of meaning and utility. These patterns will create web communities of meaning, just as individuals create neighbourhoods in cities without central administration, and ants create colonies without any conscious intention on the part of the individual ants.

Johnson defines these emergent systems against more traditional, more ubiquitous systems based on "pacemakers": central figures of order and control, founded on "command systems and hierarchies" (2001, 15). Emergent systems, because they rely on individual, relatively "stupid" agents following simple rules without central control, are fundamentally different. But need they be hostile to traditional forms of information structure?

The work of one of the earliest complexity theorists, economist Brian Arthur, suggests that complex systems often involve hostile relations between layers. Arthur argues that conventional economics has subscribed to the law of diminishing returns, a theory that posits the emergence of a stable equilibrium within an economic system. Knowledge-based industries, however, often display patterns of positive feedback, in which small, whimsical events, instead of diminishing over time, create unexpected and unpredictable dislocations:

Economic activity is quantized by individual transactions that are too small to observe, and these small “random” events can accumulate and become magnified by positive feedbacks so as to determine the eventual outcome. These facts suggested that situations dominated by increasing returns should be modeled not as static, deterministic problems but as dynamic processes based on random events and natural positive feedbacks, or nonlinearities. (Arthur 1994, 5)

Complex systems, then, often move away from stability and equilibrium, thereby making their developments and processes difficult to predict. Because small, local phenomena can overwhelm broader and more leisurely rhythms of influence, positive feedback and complexity do not necessarily produce an ideal condition. Arthur’s observations while on the Population Council in Bangladesh revealed that chronic overpopulation and human misery resulted from “a network of individual and group interests at the village level” (cited in Waldrop 1992, 26). The volatility of an emergent system can overwhelm the careful and considered scheme of conventional hierarchical organization. If Arthur is correct, we have no reason to believe that laudable long-term views will prevail over short-term views in complex systems. Local and immediate advantages may well prevail over long-term value, and if *del.icio.us* offers substantial immediate rewards, few will listen to the protestations from information architects arguing for the benefits of controlled vocabularies, facets, and other traditional forms of information structure.

Clay Shirky (2005a), in his much-debated criticism of ontologies, suggests that the relationship between tagging and classical information structures is hostile rather than benign. Folksonomies, in his view, constitute “a radical break with previous categorization strategies, rather than an extension of them” (2005a). Furthermore, Shirky characterizes their appeal as practical, prosaic, and typical of the kind of local consideration that dwarfs long-term faith that good order will prevail:

the advantage of folksonomies isn’t that they’re better than controlled vocabularies, it’s that they’re better than nothing just because it’s better to have well-designed metadata along one axis does not mean that it is better along all axes, and the axis of cost, in particular, will trump *any other advantage* as it grows larger. And the cost of tagging large systems rigorously is crippling, so fantasies of using controlled metadata in environments like *Flickr* are really fantasies of users suddenly deciding to become disciples of information architecture. This is exactly, eerily, as stupid as graphic designers thinking in the late 90s that all users would want professional but personalized designs for their websites.... (Shirky 2005b)

This view stands in stark contrast to Morville’s suggestion that tagging systems and classical information structures occupy separate layers, evolve at separate speeds, and benefit each other while remaining largely independent. If Shirky is correct, information architects, along with other proponents of controlled metadata, will see their professional contributions eclipsed by the positive feedback of local constraints: tagging may not be as good as vocabulary control in the long run, but it’s faster, cheaper and easier in the short run.

However, pace layering theory runs deeper than Brand's simple illustration in *How Buildings Learn*, just as tagging principles run deeper than the *laissez-faire* myths that surround them. Is it possible that pace layering has more to offer us than a series of concentric shapes and parallel arrows?

From pace layering to resilience theory

Ecological studies may provide a means of enriching pace layering theory as it applies to information architecture. Information studies frequently speaks of "information ecologies" as a metaphor for the way information systems exist within "local habitations" of cultural institutions, familial and social relationships (Nardi & O'Day 1999, ix). This approach has numerous advantages: in particular, seeing systems as ecologies emphasizes the interaction of players over the stratification of layers. The various players in an information ecology certainly have different roles to play and different actions to perform, but their actions affect each other, and this interaction is built into the model.

In addition, the fields of ecology and environmental studies use pace layering as a means of modeling interaction between different elements of an ecological system as it evolves over time. Ecologists, however, treat ecology and ecological cycles not as a metaphor but as a concrete phenomenon in our physical and natural environments. In so doing, they are deeply concerned with using models such as pace layering to prescribe optimum behaviour in the present and to assess future consequences. Applying these theories and models to information architecture problems may lead to a more sophisticated understanding of the relationship between tagging and classical information structures.

Ecology research places pace layering within the context of resilience theory, which seeks to understand the role of change in complex adaptive systems (Holling, et al. 2002). Resilience theory proceeds from four basic assumptions:

- Eco-systems do not change continuously or chaotically, but through periods of relative stability punctuated by sudden change that reorganizes the entire system;
- Change at all levels is discontinuous, patchy, and non-linear. Consequently, it is difficult to analyze how smaller systems scale up to larger sizes;
- The destabilizing forces in ecosystems maintain diversity, flexibility and opportunity, and are therefore as important as stabilizing forces to the system's long-term survival;
- Ecosystems that strive for constant yields, independent of changes in scale and context, attain a false stability that is unable to absorb changes, thereby losing resilience and becoming vulnerable to failure (Redman & Kinzig 2003).

If we adhere to resilience theory assumptions in an information environment, we can expect the following. First, we can expect that collaborative tagging systems may take time to evolve without any serious impact on information architecture practices, but will suddenly produce an influence that will radically change the underlying structure of the information environment. Second, even if tagging has a disruptive or destabilizing force on Web architectures, that very disruptiveness can have positive effects, by increasing the diversity and flexibility of that architecture. And finally, we ignore "mob indexing" at our

peril; by refusing to change our methods or our approaches in the face of collaborative tagging systems, we run a serious risk of allowing information architects to become anachronisms in emerging information environments. The implications underlying *Flickr* and *del.icio.us*—that vocabulary control, disambiguation and consistency are not always necessary for good information experiences—could lie dormant for a period of time, and then produce changes that completely overwhelm the slower structures of an information architecture.

Those parts of a system that have large and slow rhythms of change contribute to the preservation of memory within the system. The small and fast layers, however—those presumably represented by tagging and folksonomies—frequently affect the larger and slower layers through revolt: destructive energy which destabilizes the entire structure. This fits with paradigms of complexity theory, in which complex systems, if unable to evolve in response to external stimuli, merely freeze in place or disintegrate (Waldrop 1992). If the fast layers affect the slower layers in a destructive way, they produce either chaos, or an unproductive stability in which change consists primarily of “the destructive act of creation”: destroying what exists and then reinventing the wheel (Morville 2001).

Information architects can respond to these challenges in two primary ways. On the one hand, IAs can voluntarily choose to align themselves with the leisurely forces of stability and memory, continuing the commitment of the profession to reinventing and reviving tools of librarianship and information organization in web environments. This approach has precedents: library schools continue to teach traditional cataloguing, and cataloguing continues to be relevant in many traditional libraries. However, Web search engines had an iconoclastic effect on earlier information retrieval systems such as catalogues, because, in their design and structure, they violated some of the most basic assumptions about metadata and trust (Lynch 2001). While these violations forced us to form more sophisticated and realistic notions of structure and metadata, they have pushed more traditional tools such as library catalogues from the center to the periphery of information services. “Mob indexing” could conceivably have the same effect on traditional information architecture.

On the other hand, information architects could elect a second option: repositioning themselves as guardians, not of a system’s architectural stability, but of its ecological resilience. Such a role would involve negotiating and monitoring the many complex and unpredictable ways in which fast layers such as tagging interact with slower layers such as controlled vocabulary maintenance. Such a role relies less on the metaphor of architecture, and more on the metaphor of urban planning. The information architect, therefore, will need to design a system which interacts with tagging systems in a way that channels such energy into evolutionary patterns, rather than allowing that energy to overwhelm the architectural structures at the lower, slower layers. In this sense, the tagging phenomenon represents the greatest challenge we have yet faced in our field’s working relationship with complex systems. Instead of replacing “mess” with controlled vocabularies and sound hierarchies, we must now accept the mess of folksonomies into a permanent relationship with our ordered structures. We need theoretical and practical insights from other complex systems to ensure that this relationship remains productive, rather than destructive.

Towards a research agenda for information architecture

A central goal of information architecture is to create scalable, adaptive, and resilient information environments. Collaborative tagging appears to have potential for moving the field closer to this goal. However, our examination of pace layering and complexity theory indicates that a productive relationship between tagging and classical information structures is unlikely to occur through laissez-faire librarianship.

To understand the relationship between tagging and classical structures, richer theoretical foundations are required. Currently, information architecture theory is based on concepts imported from well-established fields, such as library and information science, cognitive science, usability engineering, and human-computer interaction. We have shown that ecology should be added to this list, especially when we consider the potential for tagging.

Of course, theoretical foundations must be supported by evidence, and an information architecture research agenda must combine theoretical advances with empirical studies. By exploring the implications of pace layering, complexity theory, and resilience theory, we have tried to show the need and value of new theoretical directions. This in turn suggests a range of empirical investigations. For instance, empirical work could use such resources as the Internet Archive, to track historical changes in web architecture, looking, as ecologists do, for “connections between slow and fast processes, or between rare events and ecological transformations” (Carpenter 2002, 2070). Finding these connections could enrich our understanding of how and why Web content changes under various circumstances, thereby dramatically enhancing the forecasting power of our field.

In particular, we wish to highlight two general directions for future research, both theoretical and empirical.

User-centered research

The advent of tagging systems has created a need for new user studies that investigate the relationship between faster and slower information layers, as manifested in user preferences and behaviour. Such studies would involve:

- Longitudinal and observational studies of patterns in user behaviour. Do users consistently use tags? Or does tag usage rise and fall? Do they categorize in ways that are, in any way, similar to controlled vocabularies? Or in entirely different ways?
- Testing of prototypes which integrate tagging with more traditional activities in imaginative and innovative ways. These could include tools which temporarily superimpose simple ontologies upon tagging results, or temporarily transform tagging results through such techniques as semantic zooming or a magic lens. (Bier et. al. 1993 ; Spence 2001)

System-centered research

This class of research activities would focus on the system rather than the user, using various methods to detect emergent and adaptive patterns in the information ecology as a whole. These would include:

- Mathematical modeling for prediction and forecasting. The purpose of science is to seek explanations for phenomenon. Often, these explanations lead to predictive tools. If current trends persist, will the system improve or decay? Can we plot a trajectory of the long-term growth and evolution of the system?
- System metrics. How can we measure and evaluate the performance of an information system? Traditional measures, such as precision and recall may have some value in the next-generation systems, but new measures will undoubtedly be required. Stability is an important concept in ecology, but how can stability be operationalized in a tagging environment? What about resilience? Are there any additional metrics applicable to the kind of information structures and environments suggested by tagging and other innovations?

Summary

Information architecture has a history of incorporating approaches and theories from other fields: graphic design, library science, cognitive science, usability and human-computer interaction. To date, however, these cross-disciplinary influences have been used directly to improve practice. We hope, through this initial framework, to show how research can be used to enrich this process. We aim to show how other fields can be used to create a body of theory that belongs uniquely to information architecture, and which, once created, can affect IA practice on a much wider scale. At the very least, such efforts will enrich our understanding of our field; at best, they may ensure the survival and the healthy evolution of our best work.

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