Places for Digital Ecosystems, Digital Ecosystems in Places

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ABSTRACT
The relationships between the concepts of "cyberspace" and "digital ecosystem" are presented based on a four-dimensional approach to the concepts of space and place. We contend that "cyberspace" is a spatial metaphor for the familiar places in the digital environment; and we argue that a "digital ecosystem" is neither a synonym for cyberspace nor an abstraction of certain features of digital environments in general. Rather, "cyberspace" and "digital ecosystem" are overlapping and mutually complementary concepts. This complementary relationship leads to an intertwining of their definitions and points to communicative, cooperative and compatible principles for the design of interactive systems that are practically operationalized in the dimension of shape, structure, context, and experience.

Categories and Subject Descriptors
H1.1 [**Systems and Information Theory**]: General systems theory, information theory, value of information.

General Terms
Design, Theory.

Keywords
Cyberspace, digital ecosystems, space, place

1. INTRODUCTION
Cyberspace is one of the most significant products of information science and technology (IST) and a hallmark of the digital era. The term "cyberspace", which originated in the science fiction novel *Neuromancer* [14], carried an aura of implausibility for many years, but it is now commonplace in the digital world of Web 2.0 and represents "an open, flexible, innovative, boundaryless, global mega-platform where people share collaborative, inspirational, interactive, immersive, and multimedia experiences with people from all over the world" [19]. The notion of digital ecosystems is thus an important complement to cyberspace -- a means for conceptualizing, managing and organizing loosely coupled, interdependent, flexible and demand-driven interactive environments [6].

The notion of a digital ecosystem is widely accepted, even though much of the research on digital ecosystems has focused on interconnected systems of systems [3] and on the comparison between digital ecosystems and biological ecosystems [18]. The concept "digital ecosystem" has no single definition, perhaps because, as with "cyberspace", there is an implicit assumption that everyone understands what the phrase refers to. As Strate [31] observes in discussing cyberspace, "because [it] is everywhere, and through widening usage, threatens to become everything" [31: 383], growing popular reference to the "digital ecosystem" without general agreement on its scope threatens to render the concept "increasingly more vague and drained of meaning" [31: 383]. However, it is important not to gloss over the complexities of either digital ecosystems or cyberspace simply because of their ubiquity.

One possible source of the confusion surrounding these two notions is a lack of understanding of the relationship between digital ecosystems and cyberspace. Although many scholars, including philosophers, sociologists, psychologists, geographers, architects, biologists and even software designers, have struggled to explain cyberspace from the perspective of space and place [1, 4, 5, 10, 12, 15, 20, 31, 33] and to understand digital ecosystems in terms of open, complex and interactive environments [6, 3, 11], little research has been conducted to investigate the interrelationships between these two notions. Ignorance of these relationships glosses over crucial and complex issues regarding the nature of both cyberspace and digital ecosystems and obfuscates the epistemological confusions such complex issues engender.

Cyberspace and digital ecosystems are often treated as though they are distinct entities addressing very different realms: Cyberspace is seen as a broad concept with a specifically human orientation, while digital ecosystems are considered to be both more specific in their orientation and more inclusive. The approach adopted here is that cyberspace and digital ecosystems are overlapping and mutually complementary concepts that reflect the practical impact of IST on human existence and capture significant aspects of our experiences in the digital era. Thus it is important to consider the interrelationships of these two concepts and to refine their definitions accordingly in order

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to generate a more inclusive theoretical framework that will clarify epistemological confusions surrounding cyberspace and digital ecosystems, support the emergence of self-organizing ecosystems, and provide direction for theoretical research and the practical application of IST. This work also has implications for design principles in the areas of networking, data management and integration, Web 2.0 technologies, and e-services.

2. CYBERSPACE: A SPATIAL METAPHOR FOR PLACE

Traditional perspectives on space and place can be grouped in two very general categories: approaches that are horizontal in nature and those that are vertical. *Horizontal approaches* emphasize the dichotomy between space and place by characterizing space as a natural fact and place as a cultural product. *Vertical approaches* presuppose a hierarchical relationship between space and place, assuming that the notion of place cannot exist without a prior conceptualization of space.

Both perspectives are problematic when we consider how new information technologies relate to and are embedded within today's Internet Age. Maglio and Matlock [25] suggest that, because cyberspace lacks the traditional material dimensions of space and time, "people rely on experience in physical space to structure experience in virtual information spaces" [25: 385]. If space exists as a natural fact, it is obviously difficult to explain the complex relations among new information technologies, physical space and society as well as the emergence and construction of cyberspace as "the 'convergence' of computers with digital telecommunications and media technologies" [15:165]. If place is merely a subjective construct, it is difficult to distinguish between "social space" [23] and place; and, if space is a form of place or place is a form of space, then all spaces are both places and non-places, and all places are spaces. Do we really need two concepts if they are one and the same?

This conundrum demands reconsideration of current approaches to space and place if we are to establish a solid theoretical foundation for the study of cyberspace. Table 1 summarizes a proposed framework for understanding the complex relationships that exist between space and place. The four dimensions of space and place -- shape, structure, context, and experience -- indicate different levels of engagement and immersion that affect spatial references. While space and place are generally independent in the dimensions of shape, structure and context, they are closely intertwined in the dimension of experience.

Because of the lack of embodiment in the digital environment, traditional concepts of space and place are inadequate for explaining cyberspace. According to Waterworth, Lund and Modjeska [32], "we are embodied beings, [and] meaning ultimately resides in bodily experiences" [32:125]; but the absence of physical embodiment in cyberspace precludes the possibility of a sensory intermediary as well as the capacity to abstract spaces from places. As digital computation becomes more pervasive, the "traditional bounds posed by the constraints of space and time are fast being changed, in scale and scope, qualitatively as well as quantitatively" [4: 337]. This process of change has given us a new appreciation of the dimensions of space and place in "cyberspace".

Table 1. Four-dimensional perspective of space and place

	Space	Place
Shape	Spatial; neutral; objective.	Spatiotemporal; affective; intersubjective.
Structure	Undifferentiated; without boundary.	Distinct; bounded.
Context	Incomprehensible; a collection of possibilities; without behavioral constraints; conceptually unconstrained.	Known; recognized opportunities; with behavioral guidelines and expectations; conceptually constrained
Experience	Uninhabited; potential mental framework for human experience; unfamiliar and unknown.	Inhabited; everyday classification/ representation of human experience; familiar.

According to the four-dimensional framework of space and place presented in Table 1, cyberspace is necessarily spatial. However, as Waterworth et al. [32] indicate, this spatiality can only provide cues regarding the structure of cyberspace because we can only see small slices of cyberspace at any point in time. Furthermore, cyberspace is not an undifferentiated whole but an amalgamation of distinct and bounded place-like units (e.g., web sites, web pages). While cyberspace appears incomprehensible, limitless and unconstrained to the novice navigating its realms, to the experienced surfer it is governed by well-known guidelines and shared expectations. For the initiated, cyberspace is not an uninhabited or undifferentiated space without boundaries but a collection of possibilities and opportunities [25]. It is a familiar, recognizable "neighborhood" imbued with personal identities, social interactions and a multi-faceted sense of belonging. For the initiated, then, cyberspace is a place, not a space.

As a place, cyberspace exhibits spatiotemporal features. An individual can design, revise and change a website at will: Using a single url, she can have different "websites" that reflect her interests as they change over time. Cyberspace is thus fluid and dynamic. More importantly, cyberspace is not a black void but a distinct and bounded place, much like a giant shopping mall. As Maglio and Matlock [26] observe, "[u]sers are considered to be in the same place when they are currently viewing the same web page, or pages on the same web site, or pages hosted in the same domain" [26: 252]. Thus places on the web can be defined either by the web's structure of connections or by how an individual accesses them: Boundaries imposed by the infrastructure of computers, wires, fibers, and protocols distinguish different place-like units in the digital environment just as walls and doorways distinguish different stores in a shopping mall.

Cyberspace is imbued with both recognized opportunities and underlying behavioral guidelines; and Internet users have expectations for each place-like unit: They go to the CNN web site for the latest news, to Amazon.com to purchase the latest book, and to Facebook for social networking. They can predict

what they will encounter in each place-like unit, and they know what to do and how to behave. Moreover, Internet users inhabit cyberspace through "embodied" and "semantic" navigation [13: 276], allowing them "to explore virtual worlds of information using cognitive processes similar to those with which they explore the real world" [32:148]. Maglio and Matlock [26] point out that cyberspace also supports awareness of and interaction with others, providing individuals with the ability to form social groups: "[A] place does not necessarily map to a location in web space, but might be automatically constructed based on the interests and activities of web users" [26:402].

The conclusion is obvious: Cyberspace is not a "space" but a "place". The "space" in cyberspace is no more than a metaphor for a "place" constituted of "place-like" units. However, even though cyberspace is a place, it is not simply a place constructed by the digital medium. Rather, the notion of cyberspace as a place must be understood in its association with the concept of a digital ecosystem.

3. DIGITAL ECOSYSTEMS

There are two general approaches to understanding what a "digital ecosystem" is, neither of which explicitly associates this notion with cyberspace. One approach views digital ecosystems as digital environments. As Koshutanski, Ion and Telesca [22] have argued, "a Digital Ecosystem consists of institutions that compete [and] collaborate … [in] a "distributed digital environment where both partners and competitors are present and where stable and unstable coalitions are created" [22: 132-133]. In a digital ecosystem, users can connect with each other, collaborate on the creation of new knowledge, and express themselves to the world by blogging, sharing photos, or podcasting presentations and creative films [19]. In this sense, a digital ecosystem stands as a substitute for cyberspace, denoting the digital environment as a whole.

The other approach views a digital ecosystem as a set of attributes. Dini [11] suggests that, in social science, a digital ecosystem consists of a community of users, a shared set of languages, a set of regulatory norms and guidelines that foster trust, a population of services, and an open-source, service-oriented infrastructure. Moreover, "one of the fundamental assumptions of the digital ecosystems vision is that [it] is strongly dependent on finding the right balance between cooperation and competition" [11: 26]. Similarly, McLaughlin, Malone and Jennings [27] propose that a digital ecosystem "consists of diverse, distributed entities that sometimes collaborate, interacting with each other to negotiate, transact and share knowledge" [27: 295]. Thus, a "digital ecosystem" can be reduced to features of cooperation, interaction and competition.

Both perspectives are obviously problematic. "Digital ecosystem" is not a synonym for either a digital environment or cyberspace nor is it an abstraction of certain features of such an environment. Rather, "digital ecosystem" and "cyberspace" are two overlapping and mutually complementary concepts. It is the overlapping nature of these two concepts that points to an intertwining of their definitions: Cyberspace provides a place for digital ecosystems to emerge, and digital ecosystems are, in turn, place-like units (or "stores") in the digital mall that is cyberspace. Based on this understanding, we define a digital ecosystem as a virtual entity that emerges from evolving interactions and interrelationships among multiple, autonomous units such as individuals, organizations, and services.

4. INTERACTIVITY IN DIGITAL ECOSYSTEMS

Our definition of digital ecosystems carries a significant and practical implication: The design and production of a truly communicative digital environment is not limited to facilitation of the diversity and autonomy of component units, but must also stimulate the evolving process of interactions among individuals, organizations, and services. Viewed from this perspective, interactivity is a crucial principle of digital ecosystems.

According to Kenne, Gorelik and Mwangi [21], interactivity is the primary characteristic of information technologies and new media. Generally, interactivity is characteristic of systems that not only accept user input but also deliver output [2]. As early as 1989, Heeter [16] identified six dimensions on which interactivity can be assessed: complexity of available choices, user effort required, responsiveness to users, monitoring of use, ease of adding information, and facilitation of interpersonal communication. McMillan and Downes [28] suggest that interactivity increases as: 1) the goal of the environment is to facilitate the exchange of information rather than to pass control of communication to participants; 2) participants play an active role in the communication process; 3) participants act on and respond to messages; 4) temporal scheduling is flexible and responsive to participants' needs; and 5) the environment creates a sense of place. In light of these considerations, McMillan [29] proposes three types of interactivity that are characteristic of the web environment: user-to-user (e.g., comments, chat rooms, asynchronous forums); user-to-system (e.g., hyperlinks); and user-to-document (e.g., ability to add to or modify a document).

Based on McMillan's research, the interactions embedded in digital ecosystems can be operationalized as three types of evolving processes: 1) interactions among homogeneous units -- interactions among multiple individuals (e.g., users), among different organizations (e.g., websites) and among various services (e.g., software). This type of interactivity implicates the communicative principle to incorporate autonomous individuals, websites and services as three components of digital ecosystems; 2) interactions among individuals, organizations and services. This type of interactivity implicates the cooperative principle to network individuals, communities, websites, and software applications in a dynamic self-adapting process; 3) interactions between the emergent system and its various components. A digital ecosystem emerges from the first two processes of evolving interactions and interrelationships. However, the units (i.e., the individuals, websites and services) do not disappear or dissolve as the whole (i.e., the digital ecosystem) emerges. Rather, units conserve their self-identity and autonomy while interacting with one another to generate a whole. Thus this third type of interactivity implicates the compatible principle to balance individual preferences and systematic integration as well as personalized settings and generalized application.

Moreover, when considering interrelationships among place, cyberspace and digital ecosystems, these principles for designing an interactive environment become particularly significant.

5. DIGITAL ECOSYSTEMS AND PLACE

In terms of the dimensions outlined in Table 1, a digital ecosystem is imbued with spatiotemporal implications in the dimension of shape. In the natural environment, an ecosystem is a dynamic system in which living organisms interact both with one another and with their environment [9]. In line with **"**biological metaphors and isomorphic models" [11: 24], digital ecosystems "are interconnected by a network to form a complex and dynamic environment" [22:132]. Thus, a digital ecosystem is not merely a conjunction of multiple, autonomous units -- of individuals, organizations, and services. Rather, the metaphorical origin of a digital ecosystem implicates interactions not only among all the units that comprise the ecosystem but also among those units and the digital space in which they operate. Thus, while the physical world is spatial, the world of a digital ecosystem is, in fact, a "spatial cueing world" [32: 130]

Furthermore, because relationships between units in a digital ecosystem can vary over time – that is, they are sometimes collaborative, sometimes competitive, and sometimes both in separate contexts [27] -- the space in which a digital ecosystem exists is a flexible "place" that evolves over time in response to the interactions of units. In this sense, digital ecosystems cannot be understood without accounting for the concept of "place": Their emergence, evolution and continued functioning require a place that both constitutes and facilitates their spatiotemporal shape. In order to design such a system, it is not sufficient simply to construct a spatial arena: Designers must also consider temporal components such as flexible timing of communications and responsiveness to expectations and requirements of participants.

With respect to the dimension of structure, digital ecosystems are bounded and distinct, not physically or geographically but epistemologically. As Dini [11] points out, digital ecosystems "always present one interface to the users. Thus the order construction processes and the interaction frameworks … will always need to be compatible with one 'boundary condition': the specification of the services and the behavior of the users that the software needs to adapt to" [11:36]. As a place -- as an amalgamation of distinct places -- cyberspace is bounded either by the web's structure of connections or by the way in which individuals access a place. Embodied in the distinct places of cyberspace, digital ecosystems are bounded by user-generated content and user requirements and expectations. Thus, while cyberspace demarcates the general boundaries of a digital ecosystem, digital ecosystems are the specific places that comprise cyberspace. This indicates that, for a truly immersive digital environment, it is important to design -- or, as Harrison and Dourish [17: 70] contend, to design for -- a sense of "specific place", not simply a vague *deja vu* suggested by spatial layout.

Digital ecosystems are "distributed adaptive open socio-technical systems" [7]. In line with the dimension of context, they offer known or expected opportunities within the constraints of underlying behavioral guidelines and expectations that facilitate self-organization, self-management, scalability, and the provision of complex solutions in the digital ecosystem [24]. However, while cyberspace tends to emphasize similarity to and consistency with the physical world, a digital ecosystem provides opportunities for complex solutions that emerge from within the system itself rather than being imposed from outside the ecosystem. In the process of exploring, innovating, testing and adapting, digital ecosystems generate their own content and their own rules based on user needs and the interaction among users and interfaces. Opportunities and guidelines are created within and emerge from the system, realizing the goal of interactive communication in digital ecosystems. The ecosystem must provide support for exchange of information among participating units rather than forcing them to assume full responsibility for the success of communication efforts.

In the dimension of experience, both cyberspace and digital ecosystems support interactive experience. According to Jorgensen et al. [18], a digital ecosystem is more than the sum of its entities or "the summed environments of its component eco-systems" [18: 22], reflecting the synergistic principle that new properties emerge when events and entities come together to form larger wholes [18: 19]. Experience in a digital ecosystem is not simply the sum of various experiences acquired by independent entities (e.g., individuals, organizations, services, software). Given that digital ecosystems are never static but "cohere through the co-adapted and coevolved states, and complicated interwoven activities, of their members" [18: 22], experience in a digital ecosystem is necessarily holistic, diverse and expansive, continuously evolving in a fluid and dynamic process. Thus the design and construction of successful digital ecosystems depends on the ability to provide complex and immersive experiences -- complex because these experiences emerge from the synergy of fragments that comprise individual experience; and immersive because the experiences are themselves responsive, self-organizing and self-adapting.

6. CONCLUSION

To explore the intellectual puzzles surrounding cyberspace and digital ecosystems and to develop principles for the successful design of digital ecosystems, we have analyzed their interrelationships based on a four-dimensional approach to the concepts of space and place. We reject the idea that cyberspace is simply a "space" and conclude, instead, that "cyberspace" is a spatial metaphor for familiar places in the digital environment that have become, for many, such an essential part of everyday life; and we argue that a "digital ecosystem" is neither a synonym for cyberspace or a digital environment nor an abstraction of certain features of such environments. Rather, "cyberspace" and "digital ecosystem" are overlapping and mutually complementary concepts. And it is this complementary relationship that leads to the intertwining of their definitions: Cyberspace constitutes the places of digital ecosystems, while digital ecosystems function as the place-like units of cyberspace.

Building on this understanding, we conclude that a digital ecosystem is a virtual entity that emerges from evolving interactions and interrelationships among multiple, autonomous units and that successful digital ecosystems must provide interpersonal communication facilities, multiple user options, and allowances for user modification as well as timely responsiveness, moderate stimulation, and ability for user adaptation to ensure complex and immersive experiences.

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