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Abstract

Scenarios are an effective tool for materializing user goals and discovering system requirements. However, system use scenarios are essentially limited to only exemplified views of real-world system use, and requirements identified through the abstraction of the scenarios often shed off necessary situational and contextual details of a user's purposeful interaction with a system. This paper explores an alternative scenario authoring method to capture discursive system use for more prosperous requirement identification. Adopting an ecological psychology perspective, we approach system use cases as an episodic narrative system. We derive five constituents of the narrative system: system genotype, user effectivity, task closure, affordance, and situational constraint, and describe focal relations between these constituents as a generative mechanism. The episodic narrative system will advance existing requirement identification methods by including situational and contextual factors and users' confrontations with them.

Keywords

Scenario, requirement identification, situational constraint, affordance.

Introduction

Scenarios are an instrumental element of systems analysis and design (SAND). Systems analysts deploy scenarios extensively throughout the SAND process, from requirement identification to system functionality and performance validation. Current SAND is squarely goal-oriented and user-oriented, focusing on how users achieve their goals through system use. A scenario in this context is defined as "a possible behavior limited to a set of purposeful interactions taking place among several agents (Rolland et al. 1998)." Scenarios are an effective tool for materializing user goals and discovering system requirements.

Scenarios build upon a use case concept in SAND. A use case is a simple usage scenario of a system, and a use case diagram provides an overview of system use by associating distinct actors with use cases across a system boundary. Crucial use cases are further elaborated into detailed use case descriptions specifying a sequence of activities, any exceptions of the primary sequence, and pre-and post-conditions. As SAND becomes increasingly agile to meet fast-changing user needs, a user story method introduced by agile design methodology replaces or complements the highly structured use case methods. The user story method formulates scenarios using a simple sentence frame and organizes them into higher-level themes or epics. This lightweight method facilitates a flexible exploration of user goals and system requirements specific to the users' task domains and allows discursive narratives of system use. System analysts can expand user stories to accommodate emerging system requirements throughout a SAND process (Irwin and Turk 2005; Somé 2006). However, the simplicity of the user stories is often limited in documenting sufficient details for requirement identification, especially in large-scale projects.

One of the challenges of using scenarios to extract comprehensive requirements is that scenarios are essentially limited to providing only exemplified views of real-world system use. Also, requirements are identified through the abstraction of the scenarios, shedding off necessary situational and contextual details influencing a user's purposeful interaction with a system. In software development, scenario-based requirement identification aims to derive detailed system use descriptions whereby diverse agents, system elements, and environmental factors interact with one another based on patterns and rules of the system encompassed by use contexts. The approach combines scenario authoring with requirement identification to reduce the distance between the two domains (Bai 2002; Park et al. 2004; Sutcliffe 1998). However, those methods are software domain-specific and may be challenging to communicate with general stakeholders of SAND.

This paper explores an alternative scenario authoring method for requirement identification to capture discursive system use cases. In particular, we intend to find ways to include situational and contextual elements of system use in SAND, noticing that users can skillfully appropriate system use for their goals in their use contexts. Inspired by the behavior setting theory (Barker 1968), we envision a user's environment involving information systems to form a behavior setting. The theory posits that properties of an environment constitute behavior settings enabling specific behavior patterns. In such a setting, a user perceives patterns of possible behaviors afforded by the properties of the environment to achieve her needs at any given point in time (and place). Variations of system usage are attributed to varying users' attributes and their engagement with the behavior setting. Those variations can be seemingly distinct but unfold like loosely connected episodes the performer generates in situ. Therefore, we approach system use scenarios as an episodic narrative system. We derive five constituents of the narrative system: system genotype, user effectivity, task closure, affordance, and situational constraint, and then describe focal relations between these constituents as a generative mechanism.

2. Theoretical Background

The thrust of describing adaptive technology use is to grasp the complexity generated from use practices and users' interactions with external factors such as material artifacts and cultural, organizational, and environmental factors (Fayard and Weeks 2014; Leonardi and Barley 2008; Volkoff and Strong 2013). Therefore, we seek to articulate a scenario development method capturing the adaptive system use by adopting an ecological lens.

The behavior setting theory (Barker 1968) postulates that all human behaviors are situated in an environment and inevitably influenced by attributes of the environment. Prevalent attributes accessible to an inhabitant form a small-scale socio-material system, inviting and enabling them to engage in specific behaviors (Barker 1968; Wicker 1984). Barker calls the system a "*behavior setting*" that induces "standing patterns of behavior" among its inhabitants. Behavior settings having similar attributes operate hence like species in that they are deemed roughly equivalent in their essential structure and likely to invite similar behaviors. Barker explains such a relationship using the idea of behavior setting genotypes defined as a set of those attributes engendering specific behavior patterns to the inhabitant (Barker, 1968). It offers standing behavior patterns configured from its present genotypes by participating actors in that capacity. Thus, surveying genotypes of a behavior setting is critical to investigating an inhabitant's behaviors in it.

The expression of behavior setting genotypes is not automatic. Behaviors result from dynamic interdependencies between thing characteristics of a behavior setting and medium properties of inhabitants of that setting (ibid.). The thing characteristics are intrinsic and stable for the genotypes in a behavior setting. They maintain the unity and stability of the environment and signify similar standing behavior patterns to all actors who enter and partake in the setting. The medium properties of inhabitants allow reconfiguring the behavior setting and acting differently. The two dimensions interact through an inhabitant's sensing and execution mechanisms that consider an inhabitant's goal aspirations and relevant program plans.

Behavior patterns of an environment are inclined to create changed milieus that support new behavior patterns or adjust the existing setting to accommodate changes in behavior patterns. An inhabitant's sensing and execution mechanisms connect the two dimensions of a behavior setting. How actors engage their sensing and execution mechanisms depends on their medium-properties and how they perceive the situation and constraints (Barker 1968; Barker 1963). An ecological environment is stratified into varied behavior settings. Each expresses its genotypes (*what a system affords*) into specific phenotypes (*what a user does with the system*) observable through a stream of an inhabitant's behavioral episodes (italics added for implications for SAND). Episodes unfold differently according to social inputs, environmental factors, or temporal conditions, while the inhabitant seeks to actualize the genotype as initially programmed.

3. Toward an Episodic Narrative System of System Use *in situ*

Narrative episodes unfold in a context and abstract away from the specifics. It helps make sense of the user's interactions with other users and elements of a system to account for the ensuing structure or the results of interactions. A narrative network is a tool for representing the actual and potential narratives created within some sphere of activity (Boje 1991; Pentland and Feldman 2007; Suchman 1987). Building upon the idea, we formulate an episodic narrative structure from which analysts generate various system use episodes. We derive five constituents that build a system use episode: system genotype, user effectivity, technology affordance, situational constraint, and task closure. In addition, we suggest four interdependencies in generating an episode: reciprocation, translation, detour, and actualization (Figure 1).

3.1. Elements of the Episodic Narrative System

System genotypes: What a user can do with the system is initially circumscribed by the inherent system attributes we call "system genotypes." System genotypes denote lower-level technical properties or combinations enabling particular features such as content format, interface, display, or platform features. A system genotype is distinct from a system feature as a tool or a system trait, which offers an abstracted dimension of the effect of using the system. System genotypes evolve similarly to the evolutionary selection process by users in their contexts. Changes in system genotypes also occur through new system development or modification.

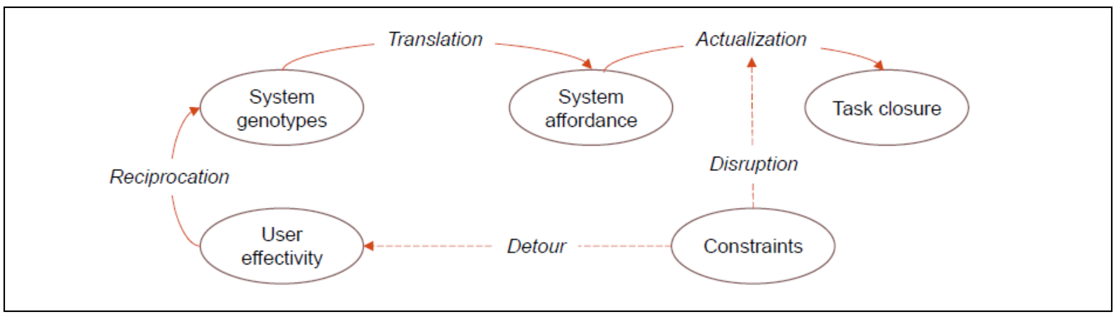

Figure 1. A Conceptual Model of Episodic Narrative System

User Effectivity: Users are typically characterized by roles or job responsibilities. This characterization is limited in encompassing diverse user types. System use requires a user's ability to interact with system genotypes of their setting under varying situations, which we call *user effectivity*. It has two essential dimensions concerning system use. Technology expertise refers to a user's capability for perceiving and executing salient behavior patterns that help her achieve her communication goals (Lee et al. 2008; Mitchell et al. 2005). Situational awareness denotes a user's capability to perceive meaningful external inputs within her environment, such as new tasks or changing conditions essential for achieving her goal. That serves as a feedback loop, whereby a user dynamically adjusts her interactions with the system and intervenes in her courses of action. Hence, repeated user experience and continual engagement modify her cognitive schemata and skills, establishing stable behavioral patterns that formalize shifts in her system use (Ortiz de Guinea and Markus 2009; Rice 2006).

Task Closure: A *goal* is defined as "something that some stakeholder hopes to achieve in the future. (Rolland et al. 1998). It motivates users to search for connections between their intended actions and the behavior setting. For example, a user can perform a sitting-on action appropriately using a chair if available in her behavior setting. However, when an actor's goal is to relieve fatigue, the goal is attainable using any objects with essential chair properties, like a tree stump (Wicker, 1984). When an actor uses that object, her goal is not to deploy its designed functions correctly but to reach her satisfaction in using it. As Barker puts it, the "satisfaction of needs via consummatory behavior (Barker 1968, p. 168)" forms an essential element of a user's goal-directed action related to system use. Likewise, the goal of system use has been shifted from generating correct system output or an end state to achieving user satisfaction.

System Affordance: The plentitude of system features in the current environment offers various ways of reaching task closure, allowing users to focus on their use patterns and achieve desired outcomes. Precise a priori perception of the expected system use is not always mandatory. Instead, adaptive system use is triggered when a user perceives possible system use patterns to bring about satisfactory task closure. We call it *system affordance*. System affordances are essentially situated and depend on how a user perceives and interacts with system genotype, user effectivity, task closure, and situational constraint coping with her varying situations (Jung and Lyytinen, 2014).

Situational Constraint: The variability of system use tends to subsume into a predictable range over time and appears to form an equilibrium inducing semi-automatic use repertoires. The equilibrium can be disrupted by external factors impeding the actualization of routinized system affordances, which we call *situational constraints*. Norman (1999) identifies three categories of constraints. Physical constraints arise from material properties of the medium such as response time, display accuracy, or reliability or usability of the technology (Leonardi, 2011). Logical constraints emerge when multiple system options offer an equivalent outcome or when a user's preferred option is not available. Cultural constraints are associated with a user's perception of cultural contexts enacting the appropriate use of the system. How users confront situational constraints conveys a sense of their adaptive system use.

3.2. Interdependences among the Elements

Reciprocation between user effectivity and system genotypes: System genotypes remain relatively stable and circumscribe system affordance within her behavior setting. User effectivities generate local variations in system use (Barker, 1968). We consider the mutually constitutive relationship as the *reciprocation* between user effectivity and system genotypes, which depends on the congruence between user effectivity and system genotypes. As the user gains technology expertise and increases her situational awareness through repeated system use, she reciprocates system genotypes to find system affordances.

Translation of System Genotypes into Affordances: Users identify potential courses of action—affordances— from system genotypes to bring out satisfying task closure, which we call translation. It bridges a set of salient system genotypes reciprocated with a user's effectivities and her situated goals to reveal how to perform consummatory actions. The translation is guided by and bound to the dispositional consequences of the available system genotypes. Users can adaptively exploit the course of action to intervene in future actions in advance and adjust their routes dynamically to find a better means for task closure.

Disrupted Actualization and Detour: Situational constraints disrupt a user's actualization of affordance. There are several ways of overcoming the constraints. Users can perceive untranslated genotypes of the setting (Stoffregen 2003; Ye et al. 2009) or find complementary system genotypes to supplement the disrupted action due to the holdback of constraints (Michaels 2003). The other is proactive countering, similar to Barker's theory. A user can prevent potential disruption by correcting or countering errors based on her initial conception. Ultimately, she can decline or eliminate sources of interfering conditions (Barker 1968).

Actualization and Task Closure: Translation of system affordances does not generate an action automatically but must be performed by a user, which we call actualization. It is "what happens at the conjunction of complementary affordances and intentions or goals (Stoffregen 2003, p. 125)." We can define the actualization of affordances as a user's performance of a course of action expressed in her current perceived affordances. The extent to which a user can identify and perform these courses is critical for task closure, which influences her adaptive system use because she shows how she can cope with situational changes.

4. Discussion and Future Directions

The proliferation of new system features and their pervasive presence increases the complexity of system use. Effective scenario authoring will help systems analysts identify functional and non-functional requirements, envisioning how the system unfolds in use contexts. The use of ecological approaches has led to attempts to contain the complexity of system use by introducing increasingly rich schemata for system differentiation (Gibson and Gibson 1955). In the subsequent phases of this research, we will evaluate the effectiveness of the proposed scenario authoring method. In the first phase, we will conduct an explorative study. A group of computer science or information systems undergraduates compares the three methods—use case, user story, and episodic narrative system—using requirement identification tasks. Their task performance will be measured quantitatively and qualitatively. The results will be used to improve the current method. Then, we hope to deploy the improved method in a broader practitioner setting for confirmatory analysis. The expected results will have a twofold contribution. For research, the ecological perspective of the episodic narrative system will contribute to the existing discourse of adoptive system use. For practitioners, our method will complement the limitations of the use case method and user story method and advance them by including situational and contextual factors during requirement identification, enabling systems analysts to predict discursive future system use in situ with ease.

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