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School of Mathematical and Computing Sciences
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Use Case Analysis with Narrative Semiotics

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Technical Report CS-TR-03-10

May 2003

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Abstract

Use cases are the accepted contemporary vehicle for the capture, collection and management of functional requirements for information systems and networked e- and m- commerce environments .While employed widely, use cases lack a critical theoretical foundation. As a result, the applications of use cases vary greatly in practice. We present an analysis of use cases based on the narrative semiotics of Greimas and the narratology of Propp. Our analysis illustrates how these techniques can expose common weaknesses and implicit assumptions latent within use case texts, and can provide a principled basis for the systematic review and evaluation of use cases within information systems development methodologies.

INTRODUCTION

Use cases are the accepted contemporary vehicle for the capture, collection and management of functional requirements for information systems and networked e- and m- commerce environments (Jacobson et al. 1992, Tapscott, D. and Stevens-Guille, 2002). While widely used, use cases lack a critical foundation, and as a result, many practical applications of use cases have difficulties with their ad-hoc and unprincipled nature (Cockburn, 2001). In this paper, we explore ways in which narrative semiotics can facilitate understanding of the assumptions, implicit motivations, and goals involved in the development and evaluation of use cases. We will illustrate how semiotic techniques can expose common weaknesses and implicit assumptions latent within use case texts, and provide a principled basis for the systematic review and evaluation of use cases within information systems development methodologies.

The main objective of the paper is to suggest a method of writing user-oriented texts that would firmly ground this practice on a theoretical base, thereby improving clarity and consistency.

BACKGROUND

Jacobson is usually credited as the originator of use cases, and in their book describing their process, Jacobson et al. (1992:127) define a use case as "a behaviorally related sequence of transactions in a dialogue with the system". A more recent definition for the Rational Unified Process shows little real change, saying a use case is "a description of a set or sequence of actions, including variants, that a system performs that yields an observable result of value to a particular actor" (Booch et al. 1999). Cockburn's comprehensive book (2001) provides a detailed account of how to write use cases, and includes a good summary of the different styles of use cases. The general idea of a use case is to represent intended sequences of interaction between a system (even if not yet implemented) and the world outside that system. In the early stages of development, use cases help to focus on interactions as a way of eliciting desirable system behavior, and so help capture requirements and determine specifications. In the later stages of development, use cases help again because of the focus on interactions. The interactions can now be regarded as the embodiment of specifications that the system must meet.

Significantly, the roots of narrative semiotics and narratology lie in the study of folklore and mythology. Many semiotic models and terms were developed in an attempt to trace common patterns in myths and folktales in order to understand the 'grammar' of universal narrative. In fact, in addition to the usually credited founders of semiotics Charles Sanders Peirce (1931) and Ferdinand de Saussure (1974) [1913], semiotics is indebted to the work of ethnographers, such as Vladimir Propp (1968) [1928] and Claude Levi-Strauss (1962). This paper also draws from work in French semiotics (Greimas 1986, Greimas and Courtes 1982, Floch 2001), and narratology (Chatman 1978 and 1990, Prince 1982).

Recent work has shown that some kinds of computer programs directly encompass 'stories', such as computer games (Darley 2000, Jenkins 2000). Semiotics has been used to study the design of human-computer interfaces (Nadin 1988, de Souza 1993); more recently it has been adopted to address programming and computer use more generally (Andersen 1993, 1997) and the organisational and political contexts aspects of information systems development (Clarke 2002, Robichaud 2002, Underwood, 2002). We now address how theories of narrative are relevant for another kind of information systems 'text' characteristic in use cases. We hope to be able to offer guidance for close reading of use cases, along the line of the "reading techniques" proposed for other artefacts of information system development (Travassos, 1999).

Narrative semiotics distinguishes two levels of narrative: narrative as trajectory and narrative as schema. The first involves the sequential development of actions, and the transformation from one state of affairs to another, leading from an initial problem to a resolving climax. The second involves the positioning of agents in specific roles, as they interact in this transformational sequence. Narrative trajectory unfolds on the syntagmatic axis of discourse, where temporal enchainment dominates (the 'and then…and then' of stories). Narrative schema, on the other hand, involves the paradigmatic axis, linked with the identity of agents in relation to their actions (the 'who's who' of stories). This paper overviews the two levels and indicates their significance for use case development and evaluation. In the next section, we concentrate on narrative as trajectory, and then in a later section we address the narrative schema. We then present our conclusions.

NARRATIVE AS TRAJECTORY

Narrative trajectory favours the verbal (as opposed to nominal), or performative, aspect of narrative, focusing on what agents do, and how these actions fit in a pattern of change from one state to another. The basic model has the narrative beginning with a problem, and leading to a series of transformational stages in a developmental

sequence aimed at solving the problem. The final stage solves or fails to solve the initial problem. From a top-down perspective, the narrative is constructed around a Subject's quest to solve a problem and/or attain a desired goal, and is designated by the term 'program of action' (PA). Zooming in, this main narrative is divided into a series of sequences, which constitute mini-narratives and reflect the structure of the whole. Figure 1 represents this graphically:

initial problem → **actions and their performers** → **resolution**
(designation of a lack or question) **(liquidation of lack, or answer)**

Figure 1: model of basic narrative transformation

In this model, each set of actions transforms the previous set, like the final stage transforms the initial stage. It should be noted that this is not generated by the principle of causality, as it might at first seem. A transformation logically presupposes the previous one, but the first should not be seen as causing the second. Each situation or stage has alternative developments, which, even though they evolve from the previous stage, are not determined by it. For example, although an action is preceded by the perception of a problem, the perception of the problem does not entail this particular action. Correlatively, each choice of action dissolves other possibilities.

Although seemingly simple, this model can be traced at the base of a great many human endeavours. In fact, it can be applied to the 'quest for knowledge' itself — the stages of hypothesising:

Uncertain situation →	**Action** →	**Resolution**
Hypothesis →	**Experiment / Test** →	**Verification / Falsification**
Thesis →	**Antithesis** →	**Synthesis**

Figure 2: Underlying narrative structure of the quest to find new knowledge

The model of the narrative trajectory has been reformulated over time. A significant version in the history of literary and text analysis is the one designed by Algirdas Greimas (first presented in his Structural Semantics 1966), which borrows concepts from the work of the linguist Saussure, and ethnographers Propp and Levi-Strauss to articulate the narrative trajectory in terms of a heroic quest. According to this, a Subject/Hero undertakes to solve the initial problem through a series of tests that lead to the acquisition (or not) of a desired goal. Some of the terminology seems odd in the context of information systems, but the ideas seem familiar. Greimas distinguishes three categories of tests following the initial problem:

Initial Problem — Qualifying Test — Decisive Test — Glorifying Test

Figure 3: Model of the narrative quest

From a semantic perspective, these stages correspond to three sets of actions, or situations, namely:

- the qualifying stage corresponds to competence: the possession by the Hero of a set of resources that enable him to perform the action needed to progress to another stage
- the decisive test corresponds to performance: the carrying out of actions based on the problem in combination with the resources available to the Subject
- the glorifying test corresponds to recognition: the final solution (or lack of solution, for failed projects) that provides closure to the project.

Applicability of the narrative trajectory to Use Cases

To examine how using the narrative trajectory is relevant for use cases, consider this example of a simple use case, 'Placing an Order', presented as an example of how to apply use cases in systems development by Schneider and Winters (1998). This represents only one way in which use cases are written, but even the existence of the variety of formats shows the need for a more principled approach to use case text.

- **Precondition: a valid user has logged into the system**
- **Flow of events:**
    - **Basic path:**
        - **The use case starts when the customer selects Place Order.**
        - **The customer enters his or her name and address.**
        - **If the customer enters only the zip code, the system will supply the city and state.**
        - **The customer will enter product codes for the desired products.**
        - **The system will supply a product description and price for each item.**
        - **The system will keep a running total of items ordered as they are entered.**
        - **The customer will enter credit card payment information.**
        - **The customer will select Submit.**
        - **The system will verify the information, save the order as pending, and forward payment information to the accounting system.**
        - **When payment is confirmed, the order is marked Confirmed, an order ID is returned to the customer and the use case ends.**
    - **Alternative paths**
        - **In step 9, if any information is incorrect, the system will prompt the customer to correct the information.**
- **Postcondition: The order has been saved in the system and marked confirmed**

From (Schneider and Winters 1998: 26)

This use case is clearly based on a developmental series of actions transforming an initial problem: the user has not placed an order and wants to do so. The competence is that the user has all the resources necessary to be 'valid' so as to log into the system. The qualifying test of 'recognition' is that the system saves the data and produces a confirmation sign. As is stands, however, the use case has some weaknesses.

Firstly, not having taken into account the full implications of narrative, the case is confused as to what agent occupies the position of Subject (the positioning of agents is the topic of the next section; however, enough has been said already to make the present discussion comprehensible). Tasks 1, 2, 3, 4, 7 and 8 place the customer as Subject, while 5, 6, 9, 10 place the system in this position, and task 3 has a conditional Subject. In other words, this case is made up of two different PAs misleadingly intertwined. Actually, taking the customer as Subject, tasks 5, 6, 9 and 10 are not tasks, but responses to the Subject's actions. Therefore, it would be more productive to divide this use case into two PAs, one with customer and the other with system as Subject. This would show clearly what is expected to happen in each step and would highlight what could go wrong.

Secondly, focusing on the customer as Subject would show that this is actually one sequence in a larger narrative. It can be assumed that the customer's main goal is not to place an order but to receive the desired products. This may not be directly relevant to the system's story but it is contextually pertinent and should be acknowledged if more realism and effective customer service are sought. For example, recognising this may encourage the designer of the system to include information about other avenues of purchase or access to goods and so make the system more competitive.

Thirdly, by not recognising that there are stages, and not just steps, involved in this PA, the case makes some unwarranted assumptions about the customer's competence. In order for the PA to progress from qualifying through to glorifying stage, the Subject must make use of the skills and resources that form his competence. In the above use case, there are two steps that assume a competence that may not be there: the request for a zip

code, which defeats localization principles and limits the internationalism of the system by assuming a specific type of geographical location, and the request for a credit card number, which limits usability by closing off alternative paths of payment. By placing the customer as Subject and by dividing the steps into stages that list the assumed or ideal competence for each stage, important details would be highlighted, facilitating the design of a more comprehensive and user-friendly system. Here is how a narrative-semiotic approach to this use case would look like:

- **Main Program of Action: a user wishes to obtain X goods and uses the software as a helper to achieve this goal.**
- **The narrative sequence in which the user requests this help takes this form:**
  - **Problem: the user has not placed an order to receive the desired goods**
  - **Qualifying Test: the user needs**
    - **access to the system (specify requirements for this), and knowledge how to act in it**
    - **contact details (name and address)**
    - **a credit card**
  - **Decisive Test: the user will carry out these actions consecutively:**
    - **Log in**
    - **Select Place Order**
    - **Enter name and address (assumed competence zip code – is this necessary?)**
    - **Enter product codes for desired products**
    - **Enter credit card information (assumed competence credit card – any other ways to pay?)**
    - **Select Submit**
  - **Glorifying Test: the user will receive a Confirmed sign at the end of the actions.**

Placing the system as Subject we would get this:

- **Main Program of Action: is this task part of the broader functions of the software?**
- **Problem: the system must assist the user in placing an order**
- **Qualifying Test: the system needs:**
  - **clear indications of what the user requires to place the order**
  - **a prompt function to help direct the user in cases of error**
- **Decisive Test: the system will carry out these actions in response to user input:**
  - **Give prompt to log in**
  - **Give directions on how to place an order and on user competence (i.e. what the**
  - **user needs to successfully complete the task)**
  - **Give prompt to enter name and address (+ zip code?)**
  - **Give prompt to enter codes for desired products.**
  - **Give descriptions of products and their prices.**
  - **Maintain record of products as they are entered.**
  - **Describe payment options.**
  - **Accept user's mode of payment.**
  - **Verify information.**
  - **Save order as pending.**
  - **Forward payment information to accounting system.**
  - **Mark order as confirmed and issue an order ID.**

- **Glorifying Test: the order has gone to the responsible parties for filling it.**

Finally, the questions that need to be asked when analysing a project according to the narrative trajectory are:

- is the initial problem made explicitly clear (without which the project may remain ambiguous)?
- how many sequences are there between initial situation and resolution (making sure that the Subject remains the same throughout the sequence and point of view does not change inexplicably)?
- what competence is assumed for each task or action?
- what possible outcomes does each task or action have (this is useful to anticipate troubleshooting)?

THE NARRATIVE SCHEMA

Stories are not just about change, actions and events. In the tradition of myth and folklore, they are also about heroes, villains and desired objects. The guiding questions of the narrative schema include 'how are the constituent agents and elements of a project defined?' and 'How are they positioned in relation to one another?' In other words, 'who's in the story and what do they do?' The main operational tool devised by narrative semioticians to deal with such identities and relationships is the *actantial* model (Greimas 1982, Floch 2001).

An actant is the formal set of properties that positions a sign in a category relative to others within a semiotic system. The actant designates the possible performers of actions. An actor, or agent, on the other hand, is the specific object that gives concrete form to the abstract properties of the actant. Combining the logic of sentence structure (which consists of a subject (active agent), verb (action) and object (passive agent)) with the logic of myths and fairy tales, the actantial model recognizes six actants and places them in these positions:

The actants represent categories, which means that each of the six actants may include one or several agents (or actors). For instance, the position of Sender, which includes the motivations or reasons of an act, belief or event and, thus, underlies the causal principles with which a project is created, could be occupied by an abstract sign, such as Love, Gravity or Mind, as it could by a figural sign, such as a King, a User or a Computer Virus. Similarly, if the one who performs the actions leading to the final result is the same as the one who motivates them, the positions of Subject and of Sender are occupied by the same agent – and the same is true of the other positions. Finally, as regards long or complex narratives, the performers may be 're-shuffled', so that, say, the Helper in one sequence may become the Opponent in another.

The actantial model does not only show the relational positioning of agents in a project; it also helps to highlight the emphasis that a project may give to one set of relations over other alternatives. This, in turn, can be used to classify the types of documents produced for an IT project: Struggle, Contract or Communication. For example, user instructions focus on the relations between Subject and Object and the actions necessary to conjoin them. So, they correspond to narratives of Struggle. Project sections that profile users and aim to ascertain their needs, skills and objectives concentrate on the relations between Sender and Subject, and correspond to narratives of Contract. Persuasive material, such as proposals for funding and promotional copy for marketing of products focus on relations between Sender and Receiver – the needs or desires that the product will satisfy and the benefits it will provide. These are relations of Communication. When a document is constructed primarily around the question 'why is this happening?' it tends to involve contractual relations between Sender and Subject. When a document is constructed primarily around the question 'how can I do this?' it tends to involve relations of struggle between Subject and Object. And when a document is primarily constructed around the question 'what are the benefits of this?' it tends to involve relations of communication between Sender and Receiver.

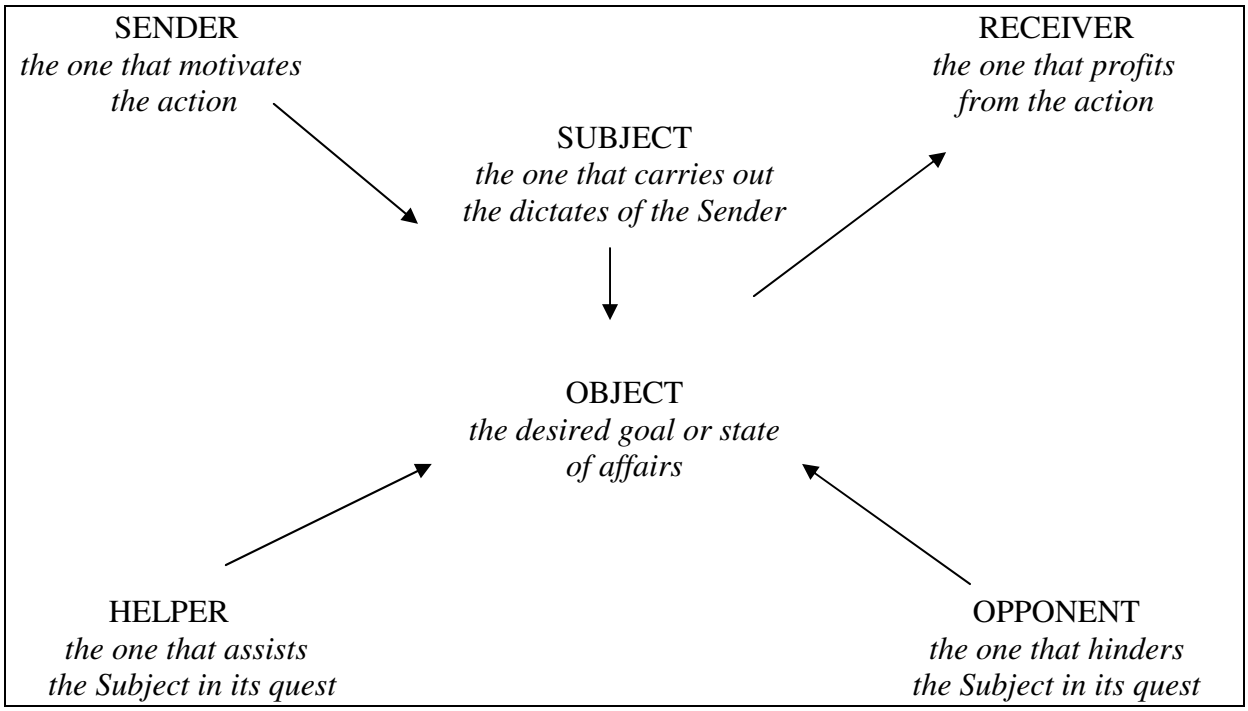

Figure 4: Actantial model

Applicability of the narrative schema to Use Cases

To examine the relevance of the actantial model to use cases, consider this actantial model representation of the use case presented early from Schneider and Winters.

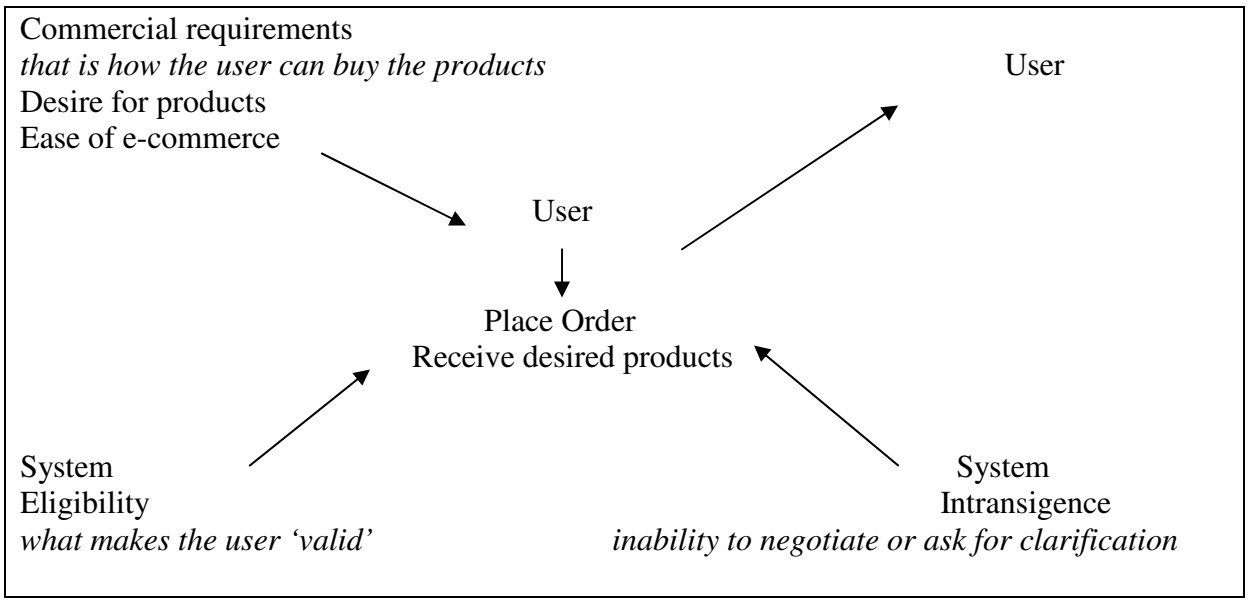

Figure 5: Actantial model of a sample use case

From the information given, and placing the user as Subject, the System can be either a Helper or an Opponent, depending on smooth usability. What motivates the Subject in its quest is the desire to obtain the goods, and the purchasing requirements: e-commerce is practical and time saving. As far as we know, the user is purchasing own products (retail), so s/he is the beneficiary of the task. Finally, the fact that the user is eligible to purchase goods in this manner helps his/her quest, while the technical formality of the process (i.e. the lack of personal contact) is

often a hindrance. Being aware of this danger enables the system designers to take measures to minimize the risk of this opposition as much as possible.

The advantage of representing this information in this form is that it renders explicit such elusive but very important aspects of a use case, such as what exactly motivates the actor, what their fears and aspirations are, what precisely they can use to their advantage to accomplish their goal, and what the short and long term benefits would be. In fact, the main purpose of the actantial model was to pinpoint and articulate the abstract, and thereby make it more conducive to analysis and understanding. The model is also likely to bring to light any 'paradoxes' of use cases – the cases where the goals are seemingly contradictory, and the cases where the same agent occupies opposing positions. For use cases, putting information in actantial positions would most advantageously be done in the planning and review stages of requirements analysis, because that is when it is necessary to become aware of anticipated helpers, opponents and benefits, define participants and objects, and establish realistic goals.

Finally, the questions that need to be asked when analysing a project according to the narrative trajectory are:

- whose perspective or point of view is taken in the arrangement of information?
- what is the rationale for placing agents in their positions?
- who is motivating the Subject in his or her quest for a desired Object?
- whose point of view has created the desired Object?
- who will benefit from the acquisition of the Object?

CONCLUSION

In this paper, we have introduced two novel approaches to the theoretical analysis of use cases: the narrative semiotics of Greimas and the narratology of Propp. Our main objective was to suggest a method of writing user-oriented texts that would firmly ground this practice on a theoretical base, thereby improving clarity and consistency. Considering use cases as narratives can address many of the common questions about them, to assist both the analysts who develop use cases and the stakeholders who must review them. We hope that these semiotic analyses can provide a platform for future progress in the research and application of use cases.

As a final note, it should be added that applications to IT may also change theories of narrative. Art (Holtzman 1997), education (Brown 2000) and even perceptions of self and other (Heim 1993) have taken different forms under the influence of the digital media. It remains to be seen whether these new forms can still be theorized using concepts and methods of narrative semiotics, or whether random access reality, projected selves, Internet identities and holographic images have created new collective mental representations that require a new theoretical language.

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