

CURRENT REQUIREMENTS ENGINEERING TOOLS AND iMUSE

by

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A thesis submitted to the Faculty of the University of Delaware in partial fulfillment of the requirements for the degree of Master of Science in Electrical and Computer Engineering

Spring 2013

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ACKNOWLEDGMENTS

I want to take this moment to express my gratitude to my adviser Kristina Winbladh for her tireless work, encouragement, and guidance to my work.

To my parents Byeonghoon and Simoak, my brother Kwangmin and all my family members. I sincerely thank you for your endless support and love.

To my colleagues Sergio and Sritama. Thank you so much for all of your hard works for this project. I could not have done it without your helps.

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ABSTRACT

With rapidly changing and growing software, the importance of Requirements Engineering (RE) has emerged as one of the primary interests of industry. There are currently tools to catalyze the RE process by featuring functionalities to sort and manage requirements; however, they fall short with regard to eliciting useful information from customers and other stakeholders. This thesis focuses on determining the criteria of a novel RE method that overcomes the current limitations of existing RE methods and implementing it as a tool. The novel method is based on a thorough analysis of available user narration tools from similar industries - User eXperience (UX) and Social video gaming. In order to effectively capture the social processes, that often are in place among a set of stakeholders, specific attention is given to narration tools that capture emotional changes and patterns among stakeholders. Finally, we integrate features corresponding to our criteria in the design and implementation of a new and improved RE tool, iMuse – Integrated Model-based Use-case and Storytelling Environment.

Chapter 1

REQUIREMENTS ENGINEERING AND CURRENT TOOLS

In the software engineering, RE tools are generally referred as requirements management (RM) tools. RM tools mainly help a software team to ‘manage’ elicited requirements. Management includes viewing and sorting requirements to better analyze their inter-relations, prioritization, and requirements tracing. The second part of the terminology RE, ‘engineering’, however, should be defined as ‘a process of creating new requirements’, and this is where most of the current RE tools could use improvements. There are no tools that truly focus on interrogating stakeholders to obtain requirements; instead this task is purely left to the requirements engineer. In addition, requirements gathered by a requirements engineer are difficult to validate as they are either captured in natural language or eventually translated from a natural language representation to a more formal description. A tool that could both capture and validate requirements would improve the RE process greatly and fulfill the needs of industry software projects with growing complexity where the human processes in place clearly need assistance.

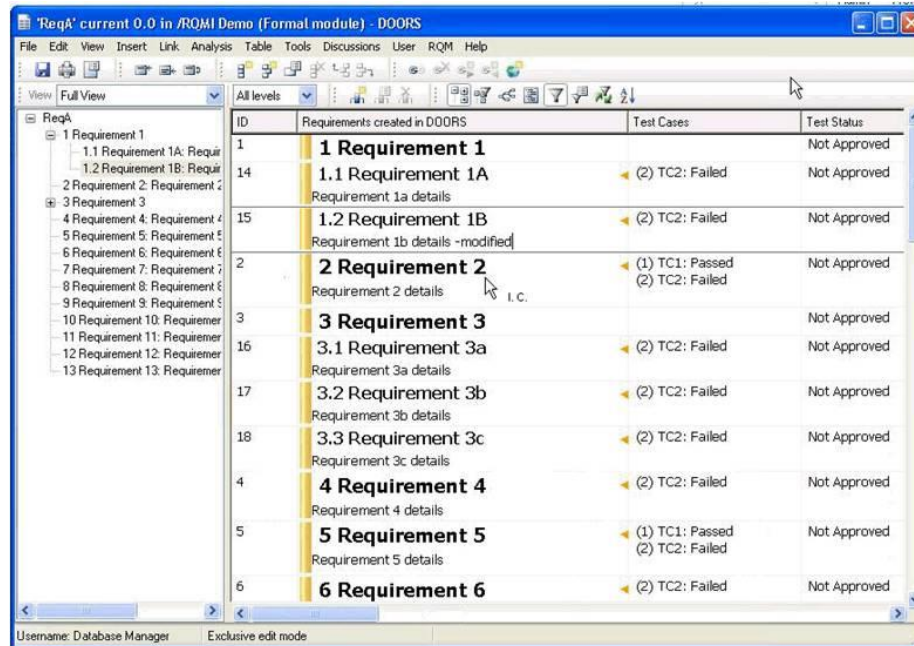


Figure 1.1: An example of Requirement Management (RM) tool. IBM Rational DOORS offers features to optimize requirements communication, collaboration and verification throughout your organization and supply chain [7].

To correctly identify existing problems and improve current RE tools, we first must understand what RE involves. RE is the disciplined and systematic approach to eliciting, specifying, analyzing, committing, validating, and managing requirements for a software system while considering its stakeholders, technical, economic, and business needs and objectives. It often spans the entire development lifecycle, involving distributed teams and iterations [14]. RE is thus a process of not only translating customers' needs from natural language into domain-specific requirements, but also a systematic way of discovering and specifying all the necessary details of a

system. This process is inherently social involving the communication between requirement engineers, designers, and stakeholders, among others.

1.1 Current features of RE tools

There are numerous RE tools in existence with features ranging from elicitation support to management [14]. Table 1.1 lists six common features of today's RE tools. With features like *requirements elicitation* and *requirements analysis*, it becomes easier for RE teams to conduct and gather information using traditional techniques including interviews and questionnaires. However, as it was mentioned earlier, these features only capture information what respondent provides, that there is only minimal to limited 'engineering' process involved. On the other hand, these tools provide some benefitting features for *requirements management* which ultimately help us to draw a roadmap for the product planning. Moreover, RE tools help to achieve the goals of systematic requirements management by supporting acquisition, specification, grouping and attribution of the raw captured requirements, supporting their derivation to more detailed levels, keeping and adjusting attributes and enabling relationships between requirements, design, realization and test to be tracked and traced [14][15].

Category of tool capability	No. of features
Requirements elicitation	37
Requirements analysis	36
Requirements specification	16
Requirements verification and validation	34
Requirements management	17
Other capabilities	17
Total	157

Table 1.1: Six major feature categories of current RE tools from 37 vendors. It is common for a RE tool to offer more than just one feature. They maximize their usability and efficiency by combining system features. Current tools mainly deliver *Requirements elicitation*, *Requirements analysis* and *Requirements verification and validation* [14].

1.2 Current limitations

Although existing RE tools offer a wide range of features and support for product planning and development, they still have many limitations. It is worth mentioning that existing RE tools are not meant to replace the human process, as this is not supported by the current features. Furthermore, current tools are not able to recognize *better* requirements. When a new requirement is generated, it is not possible to validate that indeed it is the *better* requirement compared to other possible ones. A *better* requirement is a subjective matter that it is almost impossible to define; therefore, it will be most difficult to engineer a systematic environment, which can evaluate the quality of the specified requirements. However, what we can create is a

tool that is aimed at helping its users to *think* harder, *remember* better, and *describe* more details about their current or needed processes so that these can be captured as requirements *stories*. Finally, current RE tools do not offer a feature to capture the information generated from the social interactions among different *characters* in user stories. Being able to closely observe important changes in social interactions and behavior patterns could tell us not only what the user *wanted* to do during an interaction but also how the user *will* behave next time with the similarly given circumstances. This observation can improve RE process by providing ability for both requirements engineers and stakeholders to discover and predict what specifications they ultimately agree to have on their product.

1.3 Design by example

To overcome limitations in existing tools, many good engineers and scholars study various methods and approaches from related fields and combine and apply them in a novel manner [6][14][15]. In this work, we analyze two different tools from two other disciplines. *Storify* is a user experience design tool which focuses on supporting feature sets to capture user experiences, narrated elements, and user opinions in forms of *stories*. *Comme il Faut* is a social video gaming tool that is used to provide a virtual gaming environment, which allows its *players* to explore while achieving desired objectives via social interactions and actions to/with other *players*. *Comme il Faut* also closely watches characters in action, thus carefully studying predefined character traits and makes changes to their corresponding social status.

Chapter 2

USER EXPERIENCE (UX) DESIGN TOOL

Since User eXperience (UX) is widely studied, there is no universal definition to fit all situations; however, the following simple definition is particularly appropriate for the purpose of this work:

‘The extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use’ - *ISO 9241-11 standard*

In other words, UX is the overall and beginning-to-end experience of the user while accomplishing desired objectives, commonly with acceptable satisfaction. High quality UX has become a central competitive factor of product development in a mature consumer market [17]. It is not enough to merely have a product or a service which customers are able to use, today companies are actively searching for something that will differentiate them from their competitors. UX provides this extra ‘edge’ by making it really simple for users to interact with the product or service. Designing systems with care to UX involves gathering more information about who the targeted customers are, what they enjoy doing, their interests, and what they really need. UX has been an important subject in hospitality and travel business for a long time, and UX is rapidly gaining ground in the mainstream software development as well especially with the current growing popularity of smartphones and tablet PCs.

2.1 Why a UX tool?

UX has a dynamic nature due to the ever-changing internal and emotional state of a person and due to differences in the circumstances during and after an interaction with a product [13][16]. RE also shares this characteristic being highly sensitive to its participants' physical and psychological changes during the elicitation process. In addition, both UX and RE are context-dependent in the sense that information, experiences, and opinions can be understood differently depending on how they are *contextually* represented by the narrator.

STORIFY is a multi-modal tool to provide design teams with an experiential approach towards designing interactive products by incorporating dramaturgical techniques by recognizing *storytelling* as the appropriate domain with the required expertise.

2.2 Story vs. Experience

The similarity between the key properties of a *story* and an *experience*, in the simplest way, is that they both consist of some form of *characters*, *places*, and *objects* and that they emerge from the interrelations of all three, over time [8]. This also renders their nature as subjective, context-dependent, and dynamic. They also share a sequential structure with a beginning, middle and an end. Moreover, both *stories* and *experiences* evoke and influence the emotions of their narrators and readers. Similarly, a story is a perhaps the oldest method of communication to express one's opinions. Through effective storytelling, we can retrieve information such as system requirements and user experiences. It is therefore relevant to understand the structural strategies that deliberately aim at influencing the emotions of its audience. As discussed previously, a complete story should contain *characters*, which perform

certain *actions* in given *circumstances*, usually in a chronological order. For both RE and UX, these story elements can be translated into more system domain specific information such as *stakeholders*, *required steps*, and *system requirements*.

Additionally, system design is changing into an experience-oriented discipline; consequently engineers and designers need appropriate methods to incorporate experiential aspects into their design ideas [10]. Ideally, RE and UX both have the same core principles in mind, that is to build a system that performs as designed, provides both high quality and user satisfaction, finally, satisfies its customers as desired. To establish this very goal, more often than not, we first simply have to remember how to really *listen* to what users have to tell us – get their *stories*.

2.3 STORIFY

When UX engineers and designers want to shape the experiential qualities of products and services, they often run into a number of problems. First, UX is highly subjective, context-dependent and dynamic [13]. Second, similarly to current RE tools, the existing UX design tools are not adequate to bring the emotional, contextual, and temporal aspects of an experience into discussion [18]. UX developers have thus adopted a wide variety of multi-disciplinary tools and methods into their process to address the challenges around establishing an experiential approach. Their initial efforts were to promote integration between aesthetics, marketing, ergonomics, and engineering [19] by incorporating cross-disciplinary collaboration tools such as more old-fashioned *brainstorming*, *personas*, *scenarios*, etc. *STORIFY* is a multi-modal tool to assist design teams in an experiential approach towards designing interactive products. It adapts dramaturgical techniques of film and sequential art. Specifically, it guides and assists designers in the concept generation stage by providing assistance in:

First, sorting and organizing the elements of an experience similar to the elements of a story such as *characters*, *settings*, *plot*, and *theme*. Second, communicating and discussing strategies on how to guide a user towards an intended experience.

STORIFY proposes three layers of conceptual design process namely: *Backstage*, *Stage*, and *Review* (Figure 2.1) while enhancing experiential qualities through a set of innovative design activities, i.e., UX briefing and dramatization.

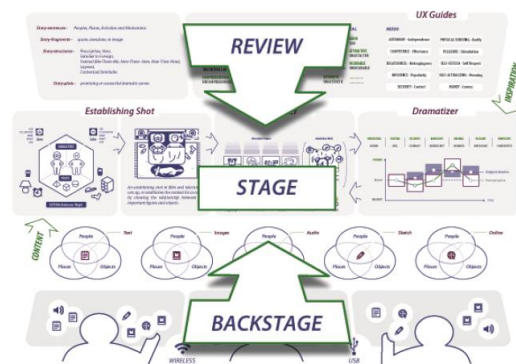


Figure 2.1: Three layers of conceptual design process of *STORIFY*: The knowledge elicited in the *Backstage* layer feeds the development process of concepts in the *Stage* layer and the results are then informed by and evaluated in the final layer, *Review*.

2.4 The three layers

In *Backstage*, the design team collects and interprets information that will assist the design process. Similarly to interviews and questionnaires in RE, this is where *STORIFY* performs its own initial elicitation through *UX briefing* – a crucial step for the design team to discover user needs and expectations then translate them into a working user experience brief that will acknowledge high-level goals and that

can provide a starting point for the conceptual User Experience Design (UXD) process. Note taking, video, and audio recording are important activities at this stage.

In the *Stage* layer, a team develops actual experiences and product concepts. Individual team member can upload selected parts of their individual collections of inspirational materials into *STORIFY*. Diverse media sources such as mock-ups, images, text, soundtracks and video clips can be used. Team members can individually arrange these items in terms of *Characters*, *Settings* and *Props*.

- *Characters* – are similar to personas; *characters* are centralized fictitious specimens that represent the targeted user group.
- *Settings* – describe the space and other surroundings of the experience
- *Props* – are the objects around the space that play role in or affect the user experience.

This breakdown helps the system to create the first frame of a storyboard clarifying the experience. The team establishes the context for the scene by showing the relationship between the elements above.

Moreover, in this second layer of the system, *STORIFY* adapts Quesenbery's and Brooks' idea of five useful aspects to add context to a story: *physical*, *emotional*, *sensory*, *historical*, and *memory* [9], which are defined as follows:

- *Physical context*: time of day, month or season, physical location, scale of location.
- *Emotional context*: characters' feelings at the moment of experience.

- *Sensory context*: context as experienced through the five senses; seeing, hearing, smelling, tasting and touching.
- *Historical context*: recognizable piece of information that places the UX at a particular time and place in history.
- *Memory context*: personal connections to the past like a ‘flashback’ that “connects one part of a story to another forcing an audience to view new story material through a remembered context”.

The *Stage* layer also provides a feature, *Keyframing*. In this layer, designers use previously gathered materials to construct a storyboard with three *keyframes*; Beginning, Middle, and End. To be able to realize in terms of *plot*, the team starts with these three basic frames to specify the experience they have in mind. The team then connects these frames with *inbetweens* and has the option to add multiple alternatives per frame to flexibly discuss various experiences. Each frame is digitally interactive and can contain multimedia information such as mock-up sketches, images, text, or recorded media files. This illustration helps the team to really visualize the user’s *experience* while understanding the chronological order of what is being told.

Finally, in the *Review* layer, previously generated concepts are evaluated by the team, users, and other interested stakeholders. Another strength of *STORIFY* is that it can present the outcome in three different presentation formats; (1) a written synopsis of the UX, (2) a comics layout and (3) a film strip.

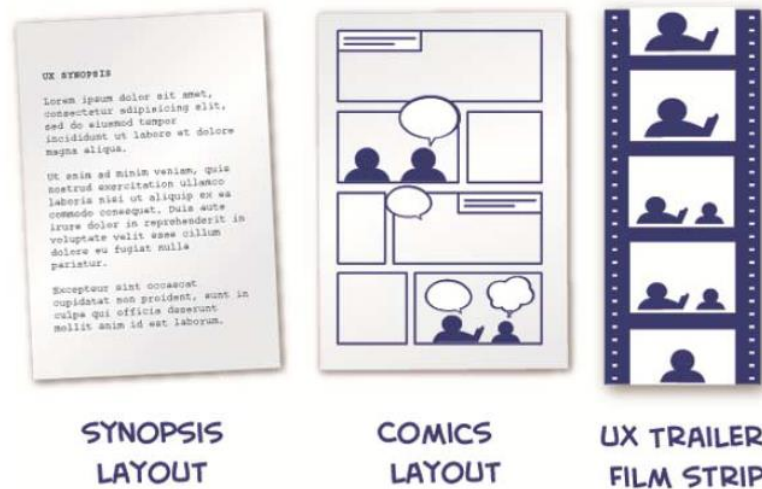


Figure 2.2: *STORIFY* can generate three different outcome formats – a written synopsis layout, a comics layout and a film strip form. Since these outcomes will be evaluated by different stakeholders with different expertise and backgrounds, having multiple outcome formats can help everyone to validate these outcomes with the minimal learning effort [10].

Once the story is generated, *STORIFY* offers a qualitative discussion protocol that aids the team in evaluating the relationship between intended and perceived user experiences. This procedure involves a structured observation protocol, pre-session and post-session questionnaires with users based on available methods from the UX literature.

2.5 Summary

As a UX design tool, *STORIFY* offers a unique system environment to illustrate user experiences. With materials gathered from *Backstage*, designers and engineers can take a new approach to understand what users sense and feel during

their *experiences*. *STORIFY* also takes an interesting method to represent these *experiences* as *stories*. A *story* is a crafted *experience* and *storytelling* is the craft. Thus, understanding the structural strategies behind storytelling and learning how to incorporate them into a product development design process is relevant for designers and engineers when they want to envision, discuss, and influence *user experiences*. This system design technique allows users to narrate their own *stories*, therefore, encouraging them to share their unique *experiences* in the most natural way possible, *storytelling*. It also effectively captures the idea that every experience should at least have three basic pieces; a beginning, middle, and end. We believe that this is a central concept for any story and therefore will incorporate it into our iMuse design. In chapter 4 we describe our Timeline concept which is used to capture the chronology of a person's story.

Chapter 3

SOCIAL VIDEO GAME DESIGN TOOL

Social games defined as common patterns of character interactions that modify the social environment of the story world. These types of games provide a useful abstraction when authoring a story composed of interactive characters, making it possible to create games with deep possibility spaces that are *about* social interactions.

3.1 Why a social video gaming tool?

Social games and video games are hugely popular and under constant technological advancement. With a massive consumer base, games often become a technological experiment stage for companies to present and venture their latest technologies. From rich storytelling to in-depth character realization systems, from hundreds of hours of addicting gaming experiences to a virtual social media with millions of *players* all around the world, we can foresee where the next generation technology destined to go. With the next generation of gaming consoles on the horizon namely; Sony's Playstation 4 and Microsoft's Xbox One, video gaming companies have showed their continuous efforts to unify various entertainment experiences with the user social interactions. Sony's newly designed gaming pad, DualShock 4, with a *Share* button, which allows a user to share anything instantly, is a prime example of

this effort. However, especially with these already highly set standards, it is not surprising to see the consumer base now demanding more genetic, more relatable, and more realistic gaming experience from the game designers and developers. Therefore, it has become crucial for game makers to find methods to create an environment with more realistic story narration and more relatable character realization.

With the rapid growth of social media such as Facebook and Twitter, it is obvious that people want to be connected in a social and digital setting. From the billions of posts that appear in social media daily, it is apparent that people want to share their experiences in this virtual world. The social video gaming world has become an ‘alternate reality’ for *players* and by closely analyzing their social behaviors in a digital world, we can seek to understand the social patterns as well as validate the usability of the system itself.

3.2 A new generation social video game

Comme il Faut, which means ‘*as it should be*’ in French, is a playable computational model of social interactions through a concept of social games inspired by Goffman’s dramaturgical analysis, Berne’s psychological games, and Reiss’s motivation analysis [11]. It also monitors rich character realization methods from other accomplished video games such as *Mass Effect* by BioWare [4] and *Sims 3* by Electronic Arts [5]. The social AI system of *Comme il Faut* also weaves concepts from the humanities and social sciences with existing AI, computer science, and software

engineering to enable the possibility of creating a richly realized interactive media experience while taming the complexities of authoring socially believable characters.

3.3 Goffman's dramaturgical analysis

Goffman's concept of dramaturgical analysis views social interactions through the metaphor of a drama; *actors, roles, settings, audience, and stage* [1]. This metaphor is particularly useful when modeling self-presentation, or the behavioral manipulation of how one is perceived by others. When social interactions are seen through this metaphor, the reasons behind behavior become more decipherable. Dramaturgical analysis provides a method to capture naturalistic interactions from everyday life patterns while keeping the normal social interactions and the context of the pattern intact. In *Comme il Faut*, Goffman's idea helps to distinguish the basic *game* environments such as *playable characters, objectives, and actionable choices*.

3.4 Berne's transactional analysis

Goffman's dramaturgical metaphor also represents patterns of normal social behaviors and their context. However, the range of interaction patterns that the dramaturgical metaphor can encompass is very large; rituals, life-long performances, and simple conversations all fall into dramaturgical analysis. Therefore, Berne's theoretical framework for transactional analysis was also considered. It creates a clear distinction between short-term and routine patterns of normal social behaviors [2]. By classifying interactions into transactions, procedures, rituals, pastimes, and games,

Berne categorizes patterns of social interaction by their complexity. Social games have their best fit in Berne's notation of game: a series of *complementary* ulterior transactions that are ongoing and organized into a predictable and well-defined outcome. Part of Berne's complexity is based on three ego states, or roles (see Figure 3.1) - parents, adult, and child - that the participants in the interaction take. If both participants take on the expected ego states for an interaction, the roles are *complementary*. One of the important distinctions that link this analysis with *Comme il Faut* is ulterior transactions. When the superficial, social ego states of the participants are in one interaction mode but the deeper, psychological ego states are in a different interaction mode, the transaction is considered ulterior or covert.

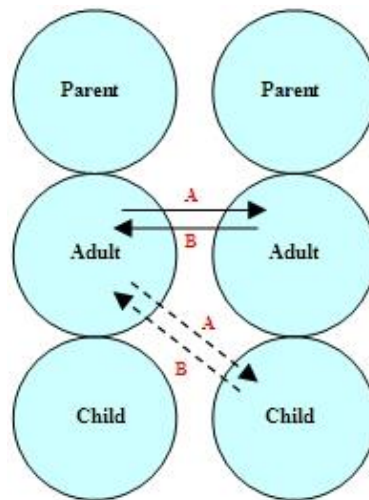


Figure 3.1: Berne's representation of an ulterior transaction where each circle represents *Parent*, *Adult* and *Child* respectively. The social interaction is represented with solid arrow lines and the psychological is dashed.

3.5 Reiss' personality motivation analysis

In addition to Goffman's and Berne's analyses, *Comme il Faut* also adapts Reiss' work on motivation analysis, which provides a conceptual continuation from Berne's games and their psychological needs. Based on an analysis of the nature of basic desires, psychological needs, also known as basic needs or life motives, are a set of 16 basic desires that need to be fulfilled. After being satiated, the desire to fulfill the basic need grows at a rate tied to the intensity of the need. Emotions can be seen as a gauge for how well these basic desires are met: positive emotions imply a well satiated individual while negative emotions suggest unmet basic needs [3].

Motivation analysis correlates basic needs and their intensities with particular character traits, Table 3.1. Additionally, separate basic needs can cause the same trait or they can combine to create a compound trait. For example, the non-conformist trait can be caused though a character having a strong intensity of the independence basic need or a weak intensity of the status basic need. The compound trait distrustful requires strong independence and weak honor. A personality profile consists of combinations of a person's intensity values for each of 16 basic needs in addition to their traits. Some common strong and weak sets of basic needs that dominate personalities have been explored with respect to normal behavior. Reiss has identified the behavior patterns of several standard personality types such as workaholic, competitor, and humanitarian, thinker, romantic, longer, and ascetic.

Psychological/Basic	Example Strong Desire	Example Weak Desire
Acceptance	Self-doubting	Self-Confidence
Curiosity	Intellectual	Practical
Eating	Overeater	Fussy eater
Family	Devoted Parent	Absent Parent
Honor	Principled	Opportunistic
Idealism	Humanitarian	Looks other way
Independence	Stubborn	Interdependent
Order	Organized	Flexible
Physical Activity	Energetic	Lackadaisical
Power	Take-charge	Laid-back
Romance	Romantic	Platonic
Saving	Collator	Extravagant
Social Contact	Extroverted	Introverted
Status	Formal	Informal
Tranquility	Timid	Brave
Vengeance	Competitor	Peacemaker

Table 3.1: Reiss' 16 basic needs with example traits for their positives and negatives. Psychological needs are linked to motivation, which provides ontology for reasoning about why *actors* perform as they do [3][11].

These traits and patterns not only allow us to study the characteristics of social interactions, but it also let us to have an ability to predict subsequent *actions* in the *story* empirically.

3.6 Mass Effect and Sims 3

At the extreme of rich character realization and limited space of social dynamic are video games with predefined options for interactions between characters and players. These are the most apparent in role playing games (RPG). *Mass Effect*, one of the most critically and commercially praised games in its genre, is a good example of this extreme. Characters are fully realized - they are individuals, with idiosyncratic responses to situations, with relevant histories, and with beliefs, attitudes, and reputations that change based on events in the game world. *Mass Effect* implements these through brute force human authoring. Many of prior-generation RPGs did this by simply writing one canonical sequence of events that always happen to the characters, revealing who they are. Unlike these more 'traditional' games, *Mass Effect* took further steps to create a world in which different things can happen and the characters respond to these events meaningfully. The dialog system still is a standard tree type that allows for only a limited set of social choices. Furthermore, only the player can affect the social state, as any social change that happens in *Mass Effect* is the result of a scripted reaction to an in-game decision of the player. These actions and different paths of the player decision throughout the gameplay ultimately alter the character interactions and event environments. Compared to *Mass Effect*, *Comme il Faut* offers a much larger social space not only to the player, but to every social character in the game. It provides a set of normal social behavior patterns, or social states according to their plans.

The Sims 3 is another example of a culturally influential and commercially successful video game that also has a highly dynamic social space. Its characters, also known as Sims, have traits and desires that inform the social practices they perform. A Sim can involve more than one practice at a time and a practice can involve more than one Sim at a time. This mechanism enables Sims and players to experience conflicting goals and intentions, which is similar to real life situations. Each Sim has traits that represent its personality, which influences the goals of that character. The goals of a Sim range from short term to long term such as lifetime wishes. These goals are determined through a combination of available social practices, traits, and the current environment. In contrast, *Comme il Faut* uses social activities and personality descriptions to generate behavior consistent with social norms; allows personality specific variations in game play; and allows social games to be played for opportunistic state changes by characters through the subversive qualities of Goffman's dramaturgical metaphor. Both *Mass Effect* and *Sim 3* are good examples of the system taking an aggressive approach to become more initiative in gathering information regarding users' story making, action choices, and social interactions.

3.7 Summary

Comme il Faut was engineered to produce playable models inspired by the concepts from the social sciences together with the understanding of drama, fiction, and authoring as understood by the humanities. The system captures characters' social behaviors and patterns by analyzing sets of personality descriptions, social state

changes, goal selection, intent formation, and performance realization processes.

These particular system design ideas have influenced iMuse's Graphical User Interface (GUI) and social interaction algorithm, which are discussed further in later sections.

Chapter 4

iMUSE - INTERACTIVE MODEL-BASED USE-CASE AND STORYTELLING ENVIRONMENT

A common RE elicitation and specification technique includes capturing user stories. These user stories can describe a user's interaction with a computer system or a current manual process for example. Typically these stories involve a *narrator* that *tells the story* and an *audience* to understand narrator's *experiences*. Eliciting and specifying user stories are commonly conducted through various types of interviews, surveys, or questioning between engineers and other stakeholders. *Stories* are a narrative way to represent and describe *experiences* from a person or an agent in a given context. The specified stories become part of the description of what the software system should do. As stories are mostly captured and described in natural language a reader is left the task of piecing information from different stories together and analyzing the story collection from the individual textual pieces.

In our work, we decided that it would be beneficial to provide the narrator and the audience support to create and analyze the stories. We call the collection of a set of analyzable stories, the *Actionable Knowledge*. The actionable knowledge provides support to a specific domain as a fragment of a plan to achieve a certain objective; however, these natural language representations are suffering from following major

problems; (1) ambiguities in decoding from a *narrator* to *audience(s)*, (2) inconsistency in narrating structure and terminology, and (3) expensive and error-prone process. As discussed in previous chapters, RE tools are gradually replacing many of above mentioned human-processes by offering a wide range of features especially digitizing essential RE activities such as requirements elicitation and requirements management. Since RE is an *engineering* process, – a selected number of professionals with diverse mindsets and personalities meet to *create* a list full of carefully negotiated *mutual agreements* for developing a product - it naturally takes a collection of hard efforts to gather, analyze, and manage requirements. Thus, for RE tools to abate current overheads, they ought to aid users to produce *better* requirements with less effort.

4.1 Methods

Interactive Model-based Use-case and Storytelling Environment, iMuse, is a model and software application tool to help stakeholders from diverse groups to narrate their *stories* and systemize their *experiences* while making direct contributions into the body of *Actionable Knowledge* by the following three methods:

- Abstract story elements – Every story has at least one *Goal*, *Plot Fragment*, and *Action*.
- Visualize social interactions by capturing action-driven mood changes in the story.
- Develop an intelligent feedback system with the growing knowledge-base which is fed by user inputs.

As for *STORIFY*'s approach in Chapter 2, iMuse also breaks down a *story* into three individual elements. A *Goal* is the objective of the *story*, and a *story* can have multiple sub-*Goals* to achieve the main *Goal*. Importantly, these objectives often become the reasons behind performed *Actions*. A *Plot Fragment* is any type of data that describes the *story* environment and preconditions associated with a *Goal* and a set of *Actions* – locations, time, and dates are prime examples. Finally, an *Action* is what usually drives the *story* forward. It can be anything that is performed by *characters* to achieve a certain *Goal*. A *character* can have more than one *Action* in a *story* and perform multiple *Actions* simultaneously. Moreover, an *Action* can involve more than just one *character* at a time.

Similar to *Comme il Faut*'s effort to understand the process of a player's decision by adopting ideas from social science and studying its social behaviors and patterns within the game, iMuse graphically visualizes the social interactions between *characters* in the *story* by periodically capturing changes in the mood and character relationships derived by each *Action*. This makes the system more precise in detecting character behaviors and patterns to predict future *Actions* in sequence based on the collected data.

Finally, iMuse employs an intelligent feedback system using the actionable knowledge that is stored in a knowledge base, which is fed by each new entry from the user. Every *story* and *experience* can manipulate and grow the intelligence of iMuse's knowledge base; thereby it can generating better feedback with time.

4.2 UNIVERSE model and GUI

iMuse has three major system components namely; the UNIVERSE model, social interaction, and knowledge-base with feedback. First, the UNIVERSE model

renders a basic storytelling environment for the GUI by providing fundamental story elements while establishing *Characters* and their traits [20]. These supported elements fit well with concepts of analyzing the *story* in different fragments as well as further realizing a *character* with its social characteristics, so-called, *traits*.

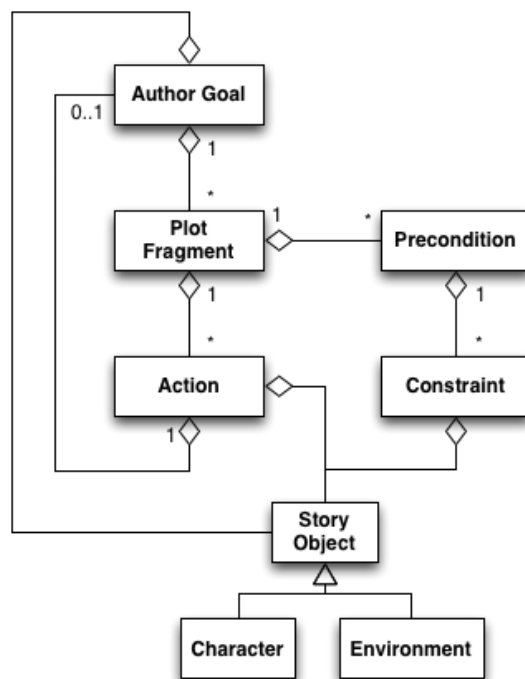


Figure 4.1: UNIVERSE model provides the back-end basics for iMuse to create a storytelling environment. Above figure demonstrates the fundamental relationships between each story element; *Goal*, *Plot Fragment*, *Action* and *Character*.

Furthermore, iMuse’s front-end GUI consists of two main segments; *Story Information* and *Timeline*. In Figure 4.2, the upper portion of the window (dark-shaded rectangle) displays the initial *Story Information* section engaged by the user with an additional objective (*Goals*) dialog window (transparent) opened. In an effort to retrieve even more accurate information, we made a design decision to represent a *Goal* with two *characters* (Who, Whom) and one *Action* (What), the second character being an optional input,

$$Char1 \rightarrow Action \rightarrow Char2 \quad \text{or} \quad Char1 \rightarrow Action$$

Intuitive GUI design guides users to submit key story elements in order by simply following numbered input fields.

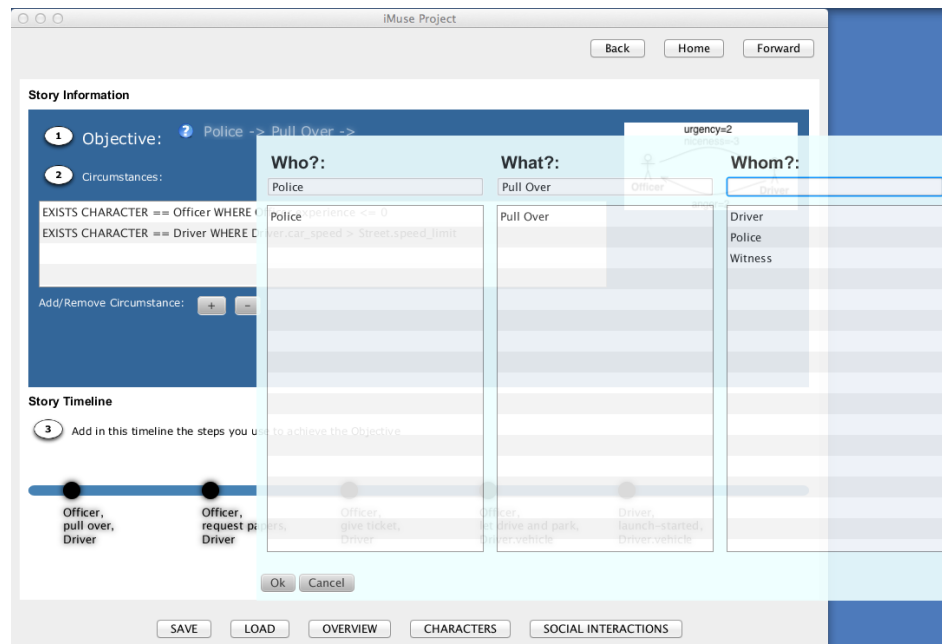


Figure 4.2: *Story Information* includes; (1) Objective and (2) Circumstances. Each represents *Goal* and *Plot Fragment* from UNIVERSE model respectively. User defines (1) Objective and its correlated characters in the *story* by entering *Who* did *What* to *Whom*. User also completes the list of (2) Circumstances by adding different precondition items.

Plot Fragments can be added or removed to the Circumstances field (Figure 4.2). These items are then categorized by the user into either *Global Circumstances* or *Local Circumstances*, depending on their degrees of commitment of being affective throughout the *story*.

The *Timeline* is a visual representation of *Actions* in a chronological order. It not only helps the audience to follow the story flow, but it also allows the narrator to plot out and visualize what he is about to narrate (Figure 4.3).

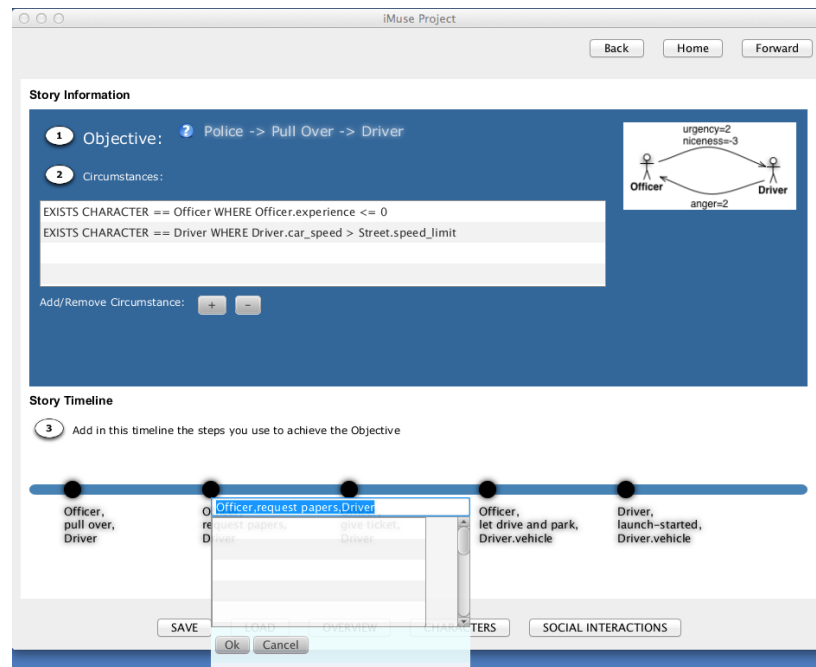


Figure 4.3: (3) *Timeline* allows both the user and the audience to visually anticipate the story flow while exhibiting its action sequence in a chronological order. Each node (dark circle) represents an *Action*, and a user can engage with it to provide more details by clicking or double-clicking a node (smaller dialog window).

The user can interact with the *Timeline* by clicking any empty space on the line then adding a single *Action* node at a time. Multiple nodes can be added and their order represents the chronological sequence of *Actions*. Importantly, if a *story* is a form of the past experience of the narrator, it should be also true that the narrator has the knowledge of how the *story* starts and where it ends. *Timeline* maximizes this advantage by visualizing narrator's retrospective details of the story's beginning, the end and everything that comes between. This idea is based on the feature of *STORIFY* that represents collected user experiences in three keyframes, equivalent to iMuse's *nodes*, with their storyboard; *Beginning*, *Middle* and *End*.

4.3 Social Interaction Representation

With defined *Characters* and traits from the UNIVERSE model, iMuse takes inspiration from Goffman's dramaturgical and Reiss' motivation analyses to visually represent social interactions of the *story*. It initially seeks for potential mood changes in the *story* such as relationship changes between characters, character existence, and global atmosphere changes for each *Action* node created on the *Timeline*.

Subsequently, iMuse visualizes this captured data on the GUI by displaying all the currently acting characters along with a relationship diagram that shows arrows between characters and a thermometer on each arrow that represents the "temperature" of each relationship (Figure 4.4). Moreover, the social interaction data feed into the knowledge base to become variables for an equation to calculate similarity of potential feedback and suggestions, along with the other elements from *Story Information*.

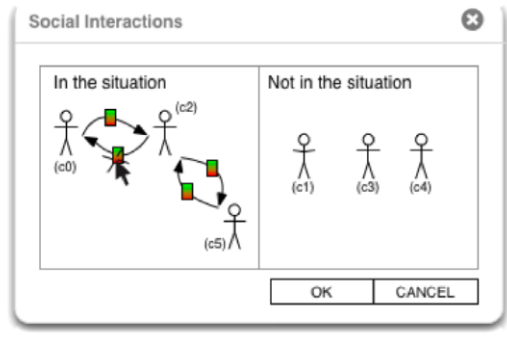


Figure 4.4: iMuse’s social interaction takes ideas from Goffman’s dramaturgical story representation and Ressis’ personality motivation analysis. Each arrow indicates the direction of character emotion whereas its colored thermometer represents the severity of each relationship. Social Interaction panel displays two separate character groups; *in the situation* and *not in the situation*.

4.4 Knowledge-base and Feedback System

iMuse’s knowledge-base is a collection of user stories in a XML back-end database. The database is populated through the GUI described above. iMuse uses the knowledge base to detect similarities between a story that is being authored and existing stories. The similarities are used to present feedback to the author suggesting intelligent alternative story paths and useful patterns. In particular, iMuse computes a similarity score between the current input story and each story in the database and discovers matches based on the highest scores. The scores are computed through graph similarity algorithms on the *Goals*, *Plot Fragments* and social interaction data. Ultimately, iMuse returns the ranked story paths to the GUI for a visual presentation to the user. The user can then decide whether or not to incorporate the feedback. (see Figure 4.5).

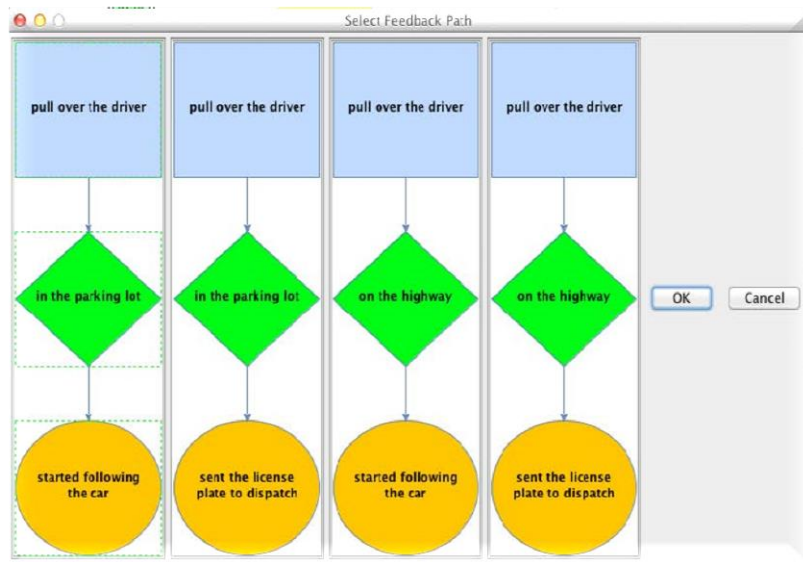


Figure 4.5: Based on similarity and relevancy of found matches against the new *story*, the feedback system ranks these matches then displays them as a group of clickable forward story paths to the user (from left to right). At this point, the user has a choice to either take a suggestion or continue to narrate own *story*.

4.5 Summary and Future Work

iMuse is a tool designed to aid the process of establishing a solid understanding between technical and non-technical stakeholders in a software project. The main features of iMuse are established on previous work that supports storytelling and social interactions in digital worlds. Each of the main features have been implemented and tested in the tool.

However, there are still limitations of iMuse. For example, the feedback system is inherently dependent on the existence of knowledge in the knowledge base. That means that the initialization of the knowledge base is important for the success of the tool. At this point we have collected an input a small set of stories into iMuse, but

the volume is still too small to thoroughly evaluate the effectiveness of the feedback mechanism. Future plans include retrieving more stories from interviews as well as from people using iMuse directly.

In addition, the social interaction mechanism could be improved in several ways. It is currently not possible to pre-render every possible combination of a *Character's* traits and behavioral patterns. Furthermore, the behaviors are subjective, which makes it difficult to accurately describe a given context of a social interaction to satisfy everyone's standard. We therefore need to establish a more universally standardized representation in addition to current thermometer analogy i.e., emoticons and a numerical scale.

Finally, the GUI will be updated with a feature to display a hierarchical 'tree' graph of the currently authored *story*. The tree graph should help the user navigate the layers of the story, and be able to validate it during creation.

Chapter 5

CONCLUSION

In a rapidly changing software engineering world, RE tools should provide the much-needed features to elicit, manage, and validate requirements. The existing tools have become a great support for engineers, designers, as well as stakeholders to expedite the process of discovering what they mutually agree for the final product . However, current RE tools are limited in their ability to capture contextual and emotional aspects of requirements engineering. In iMuse, we have adapted inspirations from other innovative tools from related fields including UX and social video gaming to represent user experiences and knowledge as *stories*. Together Goffman's dramaturgical representation analysis and the UNIVERSE model define the necessary story elements while Berne's transactional and Reiss' personality motivation analyses along with the pre-defined character traits from iMuse's back-end model create an enriched character realization system. Additionally, by capturing changes in character relationships and story moods, its social interaction component, iMuse renders an in-depth storytelling environment in an effort to provide a solution to capturing the contextual and emotional aspects of requirements stories. Thereby iMuse provides a solid base for growing the size of knowledge-base to provide richer, smarter, and more accurate requirements stories at a low cost for the user.

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Appendix

PERMISSION LETTERS

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June 12, 2013

Berke Atasoy,
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The Netherlands

Dear Berke Atasoy:

I am completing a master's thesis at the University of Delaware entitled "Current Requirement Engineering and iMuse." I would like your permission to reprint in my thesis excerpts from the following:

Atasoy, B. and Martens, J. STORIFY – A Tool to Assist Design Teams in Envisioning and Discussing User Experience. *CHI 2011*, May 7-12, 2011.

The figures to be reprinted are:

- 1- Figure 1: 'The Three Layered Conceptual Design Process of Storify' printed on page 2265
- 2- Figure 5: 'The Keyframer' printed on page 2267
- 3- Figure 8 : 'The Presentation Formats' printed on page 2268

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Sincerely,
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[Berke Atasoy]

Date: 24/06/2013

Kwang W Choi,
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June 12, 2013

Josh McCoy,
University of California Santa Cruz,
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McCoy, J., Mateas, M. & Wardrip-Fruin, N. Comme il Faut: A System for Simulating Social Games Between Autonomous Characters. *Digital Arts and Culture*, 2009.

The excerpts to be reproduced are: Human social behavior and pattern analyses of Goffman, Berne, and Reiss, printed on page 3, 4 and 5

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