Conceptual Story Modeling and Model-driven Architecture for Story Creation

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Abstract: Novels, movies and other genres of stories are popular. This paper studies the methods of computer-aided story creation by means of domain-specific conceptual modeling and model-driven architecture. Firstly, a new conceptual modeling language for story is presented, and its abstract syntax and concrete syntax are defined. The conceptual story model is a kind of graphical, highly abstract, and genre-independent model that describes the events, characters, settings, and the relationships in a given world. We developed a software tool to support the conceptual modeling. Secondly, a model-driven architecture for story creation is proposed, which consists of a series of related models, languages, and tools to support the modeling and transformation. In the architecture, a story work is represented by story models, and the story creation becomes a modeling process from abstract to concrete. We take the genre of story as the platform, so the conceptual model is a platform-independent model, which can be transformed to various platform-specific models. We believe the architecture is a new way for story creation and can make sense for the creative industry.

1 INTRODUCTION

A story is any fictional or nonfictional description of events and people that the writer has invented in order to entertain people. There are many genres of story, including novel, movie, TV play series, history and the emerging interactive storytelling. Internet facilitates the publication of story works, which attracts more people to create stories. Internet also promotes the growth of the creative industry so that more professional teams engage in creating story. The teams should work in cooperation, share information, and create story works efficiently and effectively.

The typical process of story creation is that the author firstly collects the material, then conceives the outlines, and then begins to write in detail. However, in actual writing, many writers are used to creating stories by intuition and do not conceive an outline, which leads to substantial revisions of the first draft repeatedly (Brooks, 2011). This kind of writing process can lead to the following problems: 1) lack of clear definition of creative activities, resulting in a lack of overall planning of the work, and the difficulty in supporting team creation. 2) Stories are created for a specific genre from the very beginning, which makes it difficult for stories to be transplanted to other genres. So it is necessary to develop new type of computer-aided creation methods and tools, in order to improve the traditional story writing methods and better meet the needs of the market.

Different from story and its creation which belong to the category of literature or social science, computer software and its development belong to the category of science and technology. However，there is a great similarity between the two. First, both stories and computer software are “software”, whose substance and value rely on the function and content they carry. Second, both of them are artifacts with considerable complexity. Because of this similarity, it is possible to leverage the methods in computer science and software engineering to develop new methods and tools for creating stories.

This paper studies story creation from two points of view, i.e. domain-specific conceptual modeling (DSCM) (Karagiannis et al., 2016) and model-driven architecture (MDA) (OMG, 2014). We consider story works as story models and then story creation as the process of story modeling.

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Conceptual modeling is about describing the semantics of software applications at a high level of abstraction (Embley and Thalheim, 2011). We assume that in the creating process of story works, especially those large and medium-sized story works, the conceptual model of story should be developed firstly, in order to describe the blueprint of the story works. We take the genre of story as the platform, so the conceptual model should be an abstract platform(genre)-independent model (PIM), which can be refined into a variety of concrete platform(genre)-specific models (PSMs) later, such as novel models and screenplay models. Finally, the PSMs can be directly transformed into the narrative texts for the corresponding genres. A series of related models along with the corresponding modeling tools and model transformation tools, constitute the Model-Driven Architecture for Story Creation proposed in this paper.

The rest of the paper is organized as follows: In Section 2, we propose a conceptual story model and define the conceptual modeling language. Section 3 describes a blueprint for the Model-Driven Architecture for Story Creation, and introduces the basic components in the architecture. Section 4 analyzes the related researches and illustrates the characteristic of our work. Section 5 concludes the paper.

2 CONCEPTUAL STORY MODEL AND THE MODELING LANGUAGE

2.1 From “Story” of Narrative to the Conceptual Story Model

Narratology studies the nature, form, and functioning of narrative (regardless of medium of representation) and tries to characterize narrative competence (Prince, 2003). Narratology studies how narrative works, i.e. how to “tell stories”. Generally, a narrative has two parts: “story” and discourse. “Story” is the content, while discourse is the expression, the means by which the content is communicated. In simple terms, the “story” is the what in a narrative that is depicted, discourse is the how (Chatman, 1978). Since the “story” of narrative has special meaning, it is placed between quotations in this paper to distinguish it from the story in general sense.

Narratology acknowledges the independence of “story” (Chatman, 1978), that is, people can use different discourses to express the same “story”, and the same “story” can also be manifested by multiple genres. Discourse is closely related to the genre of narrative, and it is explicit and direct. But “story" itself is implicit and is not a material object, which is hidden in the narrative text and must be described in discourse. A reader reads out or recalls the “story” after reading, as shown in Figure 1.

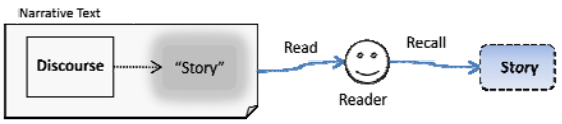

Figure 1: “Story” and discourse, the independence of “story”.

Inspired by the difference and separation between “story” and discourse in narrative, we propose a new conceptual model for story, i.e. Conceptual Story Model.

<Definition 1> Story: A story is the events, characters, settings, and the relationships between (among) them, in a given world. The world is the part in a real or virtual world that people (especially the writer of the story) are interested in.

<Definition 2> Conceptual Story Model (CSM): CSM is a visual and formal representation of story at a high level of abstraction, which can be defined as an 8-tuple:

CSM（E，C，ST，E-E，E-C，E-ST，C-C，ST-ST）

Where,

- E is the collection of events; an event is either an action or a happening.
- C is the collection of characters; a character can be real or fictitious, an individual or an organization.
- ST is the collection of settings. It refers to the physical environments, natural rules or social rules in the space of story.
- E-E is the collection of relationships between events. The relationships are temporal.
- E-C is the collection of relationships between events and characters.
- E-ST is the collection of relationships between events and settings.
- C-C is the collection of relationships between characters.
- ST-ST is the collection of relationships between settings.

CSM should have the following characteristics:

1) CSM is a Domain-Specific Conceptual Model, especially for the domain of story creation and literary criticism.
2) CSM is a Platform(Genre)-Independent Model that can be transformed into the final Platform(Genre)-Specific Story Model, such as novel, screenplay, history, interactive storytelling, etc. but CSM itself is an independent artifact.
3) CSM is a tangible representation of the narrative "story"; and a spatiotemporal model which records the time and space information of events. It arranges events according to actual time and causality, and describes the "story" only in God's perspective.
4) CSM uses graphical notation, and just employs the "minimal discourse", that means rhetoric and genre-specific discourse are not necessary and should be limited to use in CSM.
5) CSM is a non-linear, multi-dimensional view, while novel and screenplay are linear texts.
6) CSM is visual and intuitive, which is easy to be created, modified, understood and communicated. It supports team cooperation.
7) In CSM, a hierarchical structure is adopted to support a structured design process with a top-down and step-by-step refinement. And a design (creation) that gradually expands from the core can be used.
8) CSM is a model and not just a diagram, so that some software tools can be developed based on it for various applications, such as queries, statistics and transforms.

CSM is inspired by the "story" of narrative, but there are notable differences between the CSM and "story" in the following two aspects: first, the CSM is visual, concrete and independent while the "story" is implicit and dependent; second, the "story" is hidden in the existing narrative text, in other words, the narrative text exists before the "story" can be extracted from it, while CSM exists before the narrative text, it should be considered as the first version of the story work. Narratology is mainly used for literary criticism to criticize the existing story works. Although CSM can be used to represent the "story" of narrative and for criticism, a more important application is story creation; it is an early conceptual description of a story work, and a preliminary result of story creation. A CSM describes all the content to be described in the story works, so that it may have larger scope than the "story". It can be called Pre-Narrated, that is, the narrative form before the story work is formed.

2.2 Conceptual Story Modeling Language

This paper presented a Conceptual Story Modeling Language (CSML), for representing the CSM. Referring to MOF's way of defining modeling languages (OMG, 2013), we use a meta-model to define the abstract syntax of CSML and a graphical notation to represent the concrete syntax of CSML.

2.2.1 Abstract Syntax and Concrete Syntax

The abstract syntax of CSML is shown in Figure 2, where the basic modeling constructs and the connection rules are defined. The constructs and the rules are the vocabulary and syntax in a language.

The constructs are divided into two parts. One part is the elementary constructs used to define the story constructs, including some of the most basic elements, such as data type, name, and package; these are not shown in Figure 2. The other part is the story constructs that will be used to describe the CSM directly, and these are the focus of our concern.

According to the abstract syntax defined in Figure 2, a story contains: one *start*; one *end*; multiple *events*, *characters*, *settings*, and *relationships*. *Character* can be specialized to two

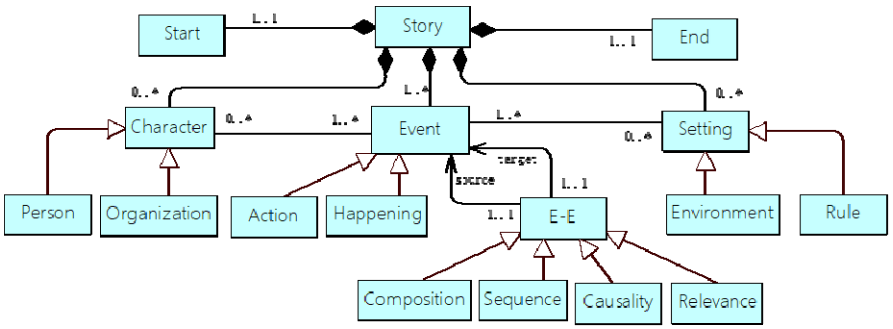

Figure 2: The abstract syntax of CSML (simplified).

specific types, *person* or *organization*. *Person* represents real or fictive characters, which can be anthropomorphic. *Organization* is a collection of person, such as a team. *Setting* can be specialized to two specific types: *environment* or *rule*. *Environment* is the physical environment where events occur, such as land, house, etc. *Rule* is the natural rule or the social rule. *Event* is the most important construct, which can be specialized to two specific types of *action* or *happening*. An *action* is a change of state brought about by an agent. A *happening* is a thing that happens, in a way that is hard to explain, such as an earthquake.

CSML can describe three kinds of relationships as follows:

1. The relationship between events (*E-E*), which can be specialized to four subtypes.
   - *Composition*. A parent event can contain multiple subevents, and these subevents are closely related. A subevent can only belong to one parent event. Events can be nested in multiple layers. Atomic events are the smallest unit of events.
   - *Sequence*. The chronological relationship between events.
   - *Causality*. A special chronological relationship, the "cause event" occurs before the "result event". the former event is a necessary condition for the development of the latter event and the latter event is the result or inheritance of the former event.
   - *Relevance*. The relationships between events other than the above three.
2. The relationship between events and characters (*E-C*).
3. The relationship between events and settings (*E-ST*).

There are also abundant relationships between characters, which are temporal and time-varying. There are also relationships between settings, which are spatiotemporal. In order to keep the modeling language concise, these two kinds of relationships are not defined in the meta-model.

We have defined a graphical notation for CSML, as shown in Figure 3, which is the main part of the concrete syntax of CSML.

Figure 3: The graphical notation of CSML.

2.2.2 Integrity Constraints and Modeling Rules

The main integrity constraints are listed as follows:

- A model must have one starting point (*Start*), one or more endpoints (*End*).
- Each of the model elements must have a unique code. Each of the events, characters, and settings must have a name.
- There is only one relationship between two events.
- An event can have 0 or more pre-relationships and 0 or more post-relationships.
- An event cannot be isolated.
- An atomic event can only associate with at most one setting.
- A non-atomic event can associate with n settings, n>=0.
- An event can associate with n (n>=0) characters, and a character can be associated with multiple events.
- If an event has multiple follow-up events, it needs to be labeled(named) in the relationships with the follow-up events.
- A duration can be marked on the relationship line between two events.
- Timeline from left to right (or top-down) is defined; events are arranged along the time axis.

CSM, a visual representation of the "story" of narrative, mainly describes the original framework of story, which is the outline and the simplest representation of the story. Therefore, the conceptual model should only contain the minimal discourse and rhetorical means. In the process of conceptual modeling, we should arrange events chronologically and describe the events in "God's perspective". Writers should pay more attention to the intrinsic coherence between events， and describe conflicts and the relationships between major individuals briefly. As for the character's thoughts, environment, and scenery, only abstract and brief expressions are needed. Since the conceptual model is Genre (Platform)-Independent, it can commendably reflect the independence of "story" of narrative.

2.3 Conceptual Story Modeling Tool

We have developed a graphical modeling tool which supports the CSM modeling; the tool is implemented based on MetaEdit+ (MetaCase, 2018). Fig. 4 shows

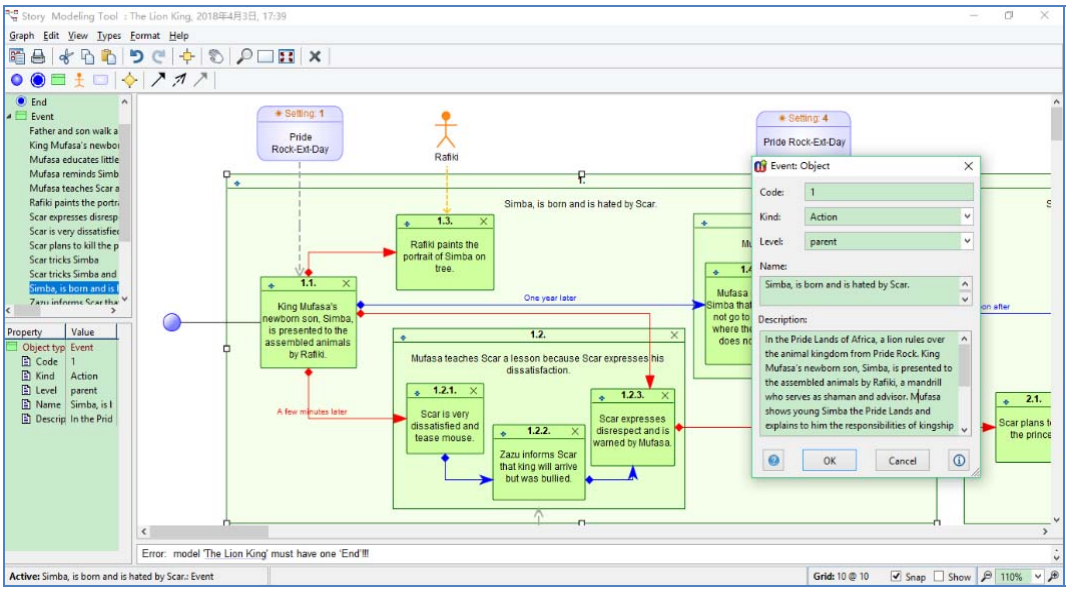

Figure 4: The CSM of "The Lion King" (fragment).

a part of CSM model of "The Lion King", which is a reengineering from the movie (Disney, 2005).

The functions and usages of this modeling tool are very similar to that of database modeling or UML modeling tools such as PowerDesigner (SAP, 2014). Those story constructs defined in Fig. 3 are placed in the toolbox of the tool, so the modeler can drag constructs to the graphic editing area handily. The graphic editing area is a two-dimensional plane that represents the story space. The X axis represents the story time, and events are arranged along it in the order in which they happened. If a complex event contains several subevents (i.e., composition), it is represented simply by embedding the subevents into the parent event. Other relationship between two events, i.e., Sequence, causality, or relevance, is represented respectively by one of the three types of relationship lines. When a leading character is involved in an event, you can represent it by drawing a corresponding relationship line between them. A number of parallel swim-lanes can be set along the Y axis. A swim-lane, an organization unit of modeling, can hold several related events and represents a storyline. After double-clicking on the graph of an event, a window will pop up in which the event can be described in natural language.

3 MODEL-DRIVEN ARCHITECTURE FOR STORY CREATION

Like computer software, story works are also software or artifacts. The internal structure and the logic in a full-length story can be very complicated. Therefore, we could benefit from the experience of software engineering to study the method of story engineering.

Model-Driven Architecture (MDA) is a software development framework launched by OMG. MDA is new approach to system development, which increases the power of model and makes model play a more important role in the process of software development. The two word-senses in which architecture is used are: A set of models with the purpose of representing a system of interest; the activity and or practice of creating the set of models representing a system.

From the viewpoint of MDA, this paper proposes a Model-Driven Architecture for Story Creation, as shown in Fig. 5.

We mainly focus on the creating or writing stage of a story. This is a process of story from intangible to tangible, elementary to advanced, and abstract (skeleton) to concrete (vivid). Whether "creating" or "writing" imply the representation of story and such a representation is a Story Model. Story creation is to design and build the story models, the process of which is called Story Modeling, it is a kind of

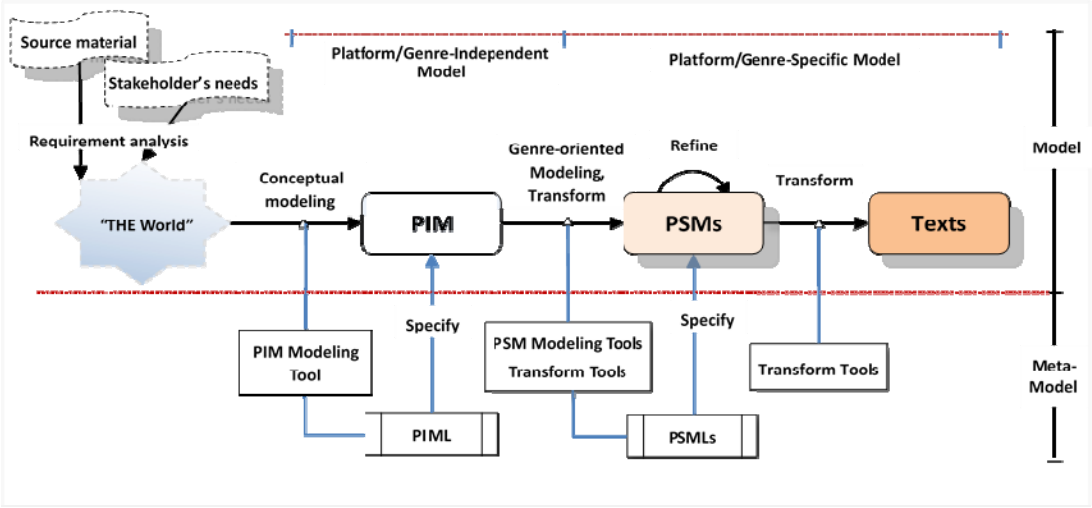

Figure 5: Model-Driven Architecture for Story Creation.

Domain-Specific Modeling. A language used for story modeling is called Story Modeling Language which is a Domain-Specific Modeling Language. Multiple modeling languages can be used to describe the same story, so multiple Story Models of the story can be obtained.

In the MDA development life cycle, PIM, PSM and code are at the core of the MDA. PIM is a model with a high level of abstraction that is independent of any implementation technology. A PSM is tailored to specify your system in terms of the implementation constructs that are available in one specific implementation technology. A PIM is transformed into one or more PSMs. For each specific technology platform, a separate PSM is generated. The final step in the development is the transformation of each PSM to code. Code is also a model that is fit in definition of model (Kleppe et al., 2003).

Three kinds of related models are introduced in the Model-Driven Architecture for Story Creation, which are Platform(Genre)-Independent Model (PIM), Platform(Genre)-Specific Model (PSM) and Text (Code). PIM is specified by Platform-Independent Modeling Language (PIML), in this paper PIM is the Conceptual Story Model which is specified by the Conceptual Story Modeling Language (CSML). A story can be represented in different genres, so a story can have different PSMs. For each genre, a Platform(Genre)-Specific Modeling Language (PSML) is needed to specify the PSM. Text is the final output, which describe story through narrative text. In order to support the above modeling processes, the corresponding modeling tools and transformation tools are needed.

PIM Modeling. We consider the genre of story as the platform, so CSM is a PIM, which is described in minimal discourse or genre-independent discourse. A PIM is specified by using the PIML. The computer-aided PIM modeling tools can offer convenience to users (writers) to design PIM.

PSM Modeling. PSM is described by using the genre-specific discourse. Corresponding to different genres, there are different PSMs, such as novel PSM, screenplay PSM and so on. A variety of PSMLs and modeling tools are needed accordingly. The model transformation tool transforms PIM to a primary version of PSM, and then writers can use PSM modeling tool to reconstruct and refine the PSM. PSM modeling tools should have some genre-specific means for the discourse, which can support writers to create more elaborate and artistic PSM.

The common means of discourse includes narrator, perspective, narrative time, characterization, narrative order and so on (Chatman, 1978). Different genres have different means of discourses. For example, the mental activities of a character can be described in detail in a novel. While in a movie, the appearance and movement of a character can be more intuitively presented, but it is difficult to describe mental activities directly like those in novel. Therefore, there should be multiple PSMLs in the architecture, which specify the platform-specific models of different genres. The PIM of a story (S) can be transformed, reconstructed and refined to several kinds of platform-specific models, such as the novel model (S1) and the movie model (S2).

After using genre-specific discourse tools, the PSM and PIM of the same story will have obvious

differences as follows: **1) Scope and granularity**. The PSM may only describe part of the PIM (event, character, or setting) after selecting and tailoring. The description in PIM is simple and highly abstract while the description in PSM is elaborate and highly artistic. **2) Dimension**. The PIM represents the relationship between events in a two-dimensional plane and can present multiple story lines at the same time. However, the PSM is one-dimensional and is a linear arrangement of events according to the needs of narrative. **3) Narrative order**. The PIM arranges events according to chronological order, that is, the actual time the story happened. The PSM arranges events according to narrative order, and can use interposing, flashback, and others, so the sequence of events can be very different from that of the PIM. **4) Narrative perspective**. PIM narrates the story in the viewpoint of the third person (from the God's perspective), while PSM introduces various narrative perspectives.

Text Producing. Different from PIM or PSM, Text is actually not a graphical model but a final narrative text that can be printed and published after being rearranged on the basis of PSM according to the publication standard of certain genre works. Therefore, there should be several transformation tools that can transform PSMs to corresponding work texts automatically. From the perspective of narratology, both "story" and discourse are same in PSM and Text for the same story, except for the different form of text. For example, for a novel (a screenplay), its Text is the novel text (screenplay text) that is arranged according to the publishing requirements of the novel (screenplay).

Model-Driven Architecture for Story Creation depicts a blueprint for a new method of story creation; it is a system engineering method and can be called as story engineering. This method is particularly suitable for creative teams, which can create story works efficiently and effectively through the sharing of information, reuse of models and the cooperation. A series of related software tools in the architecture will help the writers or creative teams better.

4 RELATED WORK

There have been numerous researches on story creation methods, which are mostly genre-specific. Brooks (2011) proposed the concept of story engineering, emphasizing the core competencies of writing story texts, but in fact it is still a method of genre-specific writing.

A number of computer-aided story creation software (tools) have emerged (Wikipedia, 2018). Final Draft is a screenplay editing software that can assist writers in writing standardized screenplay. The core functions of Celtx, Movie Magic Screenwriter, Power Structure, Story Expert, Plot Control, Movie Outline, and Power Writer are all aimed at a specific story genre (screenplay), providing a comfortable writing and editing environment for writers. Writer's Café (Anthemion Software Ltd, 2016) and WriteItNow (Ravenshaw Services Ltd, 2018) support the early design of the story and can describe events, characters, places, and other elements. The emphasis of Writer's Café is the description of events, and only sequence relationships are defined between events. WriteItNow can represent the relationship between characters and events simply, but it cannot describe the relationship between events in a visual way. To sum up, almost all the current computer-aided story creation tools are genre-specific, which is different from our method that a variety of genre-specific models can be built based on the same conceptual model.

Interactive storytelling (Nunes et al., 2017) is a new form of digital entertainment in which the storyline is not predetermined. The writer creates the setting, characters, and situation which the narrative must address, but the user (player) experiences a unique story based on their interactions with the story world. Interactive storytelling is a new kind of narrative; the story world here can be considered as a story network while what a user experiences is just a route in the network. The conceptual story model presented in this paper may be an appropriate means to model the network.

As the analysis and design approaches, MDA and conceptual modeling have been used in many application areas (Kusmenko et al., 2017; Hammoudi et al., 2018; Karagiannis et al., 2016; Embley et al., 2011), such as cyber-physical Systems, enterprise architecture, requirements engineering, business process modelling, and the application of conceptual modeling of system story. The latter introduces storyboarding, actors, scenarios, tasks and plots in order to describe the usage of software systems through telling stories, this is different from our work. As far as we know, researches similar to ours have not been reported at present.

5 CONCLUSION

A new domain-specific conceptual modeling language used in the field of story creation is presented; it is used to specify CSM. CSM is a visual platform(genre)-independent model(PIM), which can be used to represent the events, characters, settings, and the relationships in a given world in a high level of abstraction. We developed a conceptual modeling tool to support the CSM modeling. Subsequently, based on CSM, by using the platform (genre)-specific discourses, various platform (genre)-specific models can be created through transformation, reconstruction, and refinement. CSM and PSMs as well as the corresponding modeling languages, modeling tools and transformation tools together, constitute an integrated story creation environment, i.e. Model-Driven Architecture for Story Creation. We believe that in the era of Internet and with the rapid development of the creative industry, it is necessary to establish and take advantage of the architecture.

The research mentioned in this paper is preliminary and we will improve and validate it continuously in the future.

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