Representing Transmedia Fictional Worlds Through Ontology

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Currently, there is no structured data standard for representing elements commonly found in transmedia fictional worlds. Although there are websites dedicated to individual universes, the information found on these sites separate out the various formats, concentrate on only the bibliographic aspects of the material, and are only searchable with full text. We have created an ontological model that will allow various user groups interested in transmedia to search for and retrieve the information contained in these worlds based upon their structure. We conducted a domain analysis and user studies based on the contents of Harry Potter, Lord of the Rings, the Marvel Universe, and Star Wars in order to build a new model using Ontology Web Language (OWL) and an artificial intelligence-reasoning engine. This model can infer connections between transmedia properties such as characters, elements of power, items, places, events, and so on. This model will facilitate better search and retrieval of the information contained within these vast story universes for all users interested in them. The result of this project is an OWL ontology reflecting real user needs based upon user research, which is intuitive for users and can be used by artificial intelligence systems.

Introduction

Twenty-first century media companies are all rushing to find their own transmedia mega-brands composed of vast fictional worlds and explored by adoring fans (Bondi, 2011; Booth, 2009; Gray, Sandvoss, Harrington, & Jenkins, 2007; Howard, 2013; Menard, 2015). These transmedia fictional worlds (TMFW) unfold across multiple mediums, including games, films, television, comics, and novels. Each of these

individual stories weaves a tapestry of continuity: across characters, places, events, science, laws, and rules, to form one single story (Howard, 2013; Jenkins, 2006). The importance of transmedia storytelling is rising as these worlds become more prominent in popular culture (Clarke, 2014; Jenkins, 2013; Menard, 2015).

"Transmedia" is often defined as including any and all parts of modern media properties including narrative and product components that are themes from the larger story; however, it is important to differentiate between elements of a media property that advance the narrative, that is, transmedia storytelling, and elements that are simply brand expressions, that is, brand franchises (Clarke, 2014; Jenkins, 2006; Menard, 2015). In addition, this paper is concerned with describing the content of transmedia and not the communication methods used by transmedia. King's (2012) description of how the media company Ubisoft approaches transmedia storytelling provides an operational definition for use in this paper:

> "A story world-building technique that produces coordinated, multi-platform stories with each … [producing] its own stand-alone narrative that creates new entries into the world."

In contrast, the term *fictional world* requires that we construct a definition by combining elements from media studies, brand marketing, and literary scholarship. The most important element is that fictional worlds are constructed from the narrative elements of the story and are often grounded in real-world or historical facts (Doležel, 1995; Eco, 2009; Fořt, 2006; Traill, 1991). However, one also needs to analyze the narrative elements within the story to understand its storyline. The following definition captures both contexts:

> The characters, associations, family trees, events, organizations, locations, science, technology, religions, philosophies, tropes, themes, natural laws and/or other components found within the narrative elements of a fictional transmedia story and their connections to reality. (Clarke, 2014; Menard, 2015)

Knowledge about transmedia stories is often stored in unstructured sources that are difficult to query. Fans are creating thousands of wikis, blogs, and fan sites to describe the various narrative elements of their favorite worlds (Booth, 2009; Gray et al., 2007). As important as fan-driven sources are, they suffer from a lack of structured data and are limited in their ability to facilitate detailed searching and analysis (Compton, 2015; Noh, Lee, & Lee, 2008; Patkar, 2011), instead relying on full-text search engines to provide access. Interested parties must review dozens of original media sources and search hundreds of fan sites to get the full picture (Clarke, 2014; Jenkins, 2006, 2013; Menard, 2015).

An ontology-based approach is a potential answer to this problem. This approach makes it simpler to provide information in intuitive ways to end users by using artificial intelligence (AI). However, this requires transmedia fictional worlds' knowledge to be organized into a standard ontology using common formats, such as Ontology Web Language (OWL) or Resource Description Framework (RDF) (Compton, 2015; Noh et al., 2008; Patkar, 2011; Su, Meng, & Hu, 2013). Current efforts to capture this information, such as the Comic Book Ontology, focus on one form of media and on accurately representing bibliographic information. These efforts rarely touch upon information contained within the internal narrative structure of the fictional world, such as laws of nature or superpowers (Petiya, 2014 [n.d.]). For example, searches performed within ontology-based search engines, such as Falcon,[1] Swoogle,[2] and Watson,[3] found no structured information about Spider-Man's age or how he obtained his superpowers. This type of knowledge is critical for users trying to understand transmedia worlds (Clarke, 2014; Doležel, 1995; Eco, 2009; Fořt, 2006; Menard, 2015; Traill, 1991). By fully representing the structure of the transmedia world, we can also compare multiple worlds, thus supporting improved retrieval and access to this cultural knowledge.

A standard ontological model of the information contained within the Transmedia Fictional Worlds (TMFW) narratives is needed for better representation and retrieval of this information. This model must be usable with the kinds of linked data ontologies that power knowledge-based search engines (Compton, 2015; Noh et al., 2008; Su et al., 2013). In this research study, we develop such a model and aim to answer the following two research questions:

> RQ1: How is knowledge contained within TMFW narratives inherently structured as a domain?
>
> RQ2: How do end users navigate, organize, and understand the information contained in TMFW narratives?

Related Work

Previous Research on Fictional Worlds

Although there have been many studies conducted on the organization of transmedia works with regard to bibliographic metadata, studies relating to metadata and organization of information within fictional worlds are lacking. The studies that exist on this subject often use a completely new methodology, as there is not enough research to collaboratively build from, or the topics are too diverse to be sufficiently relatable. This area of research has simply not had the same longevity as other fields, and the topics are wide-ranging.

Often, studies are focused more on fans and how fans interact with fictional world knowledge than how that information can be organized and utilized (Booth, 2009; Gray et al., 2007). This trend is seen due to many studies being conducted on how fictional worlds are structured and what kind of themes are contained within, such as metaphors or explicit/implicit facts (Degani-Raz, 2003, 2005; Doležel,

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[1]http://ws.nju.edu.cn/falcons/objectsearch/index.jsp
[2]http://swoogle.umbc.edu/
[3]http://watson.kmi.open.ac.uk/WatsonWUI/

1995; Hantke, 2014; Papoušek, 2006; Traill, 1991). Thus far, none of these studies have fully addressed how these fictional worlds' structures and interrelationships can be organized using ontologies or other means. One study that researched the characters within fiction focused on how readers relate to those characters, concentrating more on themes and interpretations than on organizing information (Eco, 2009). Other transmedia studies focus more on the relationships between the various media formats, or what designates an item as being "canon" or "noncanon" (Menard, 2015).

The concept of "canonical" versus "noncanonical" components is often discussed regarding TMFW. The distinction is necessary because fans create their own stories that are not sanctioned or known by the owner(s) of the world (Bondi, 2011; Booth, 2009). Even licensed third parties can deviate their story narratives in ways that do not have the full sanction of the world's owners, e.g., the Star Wars Expanded Universe (Lucasfilm, 2014). Consequently, there has traditionally been the need to designate the components of a fictional world as either "canon" or "noncanon."

However, this distinction is complicated by the fact that owners of transmedia properties often create their own sanctioned variant storylines. For example, the character Hawkeye exists simultaneously in the Marvel Universe in two separate but authorized incarnations (Fraction, Aja, Pulido, & Hollingsworth, 2013; Hickman, Sandoval, & Anderson, 2011). Also, in rare cases, "canon" can become a unified consensus of the fan community as opposed to that of the owner(s), although this usually happens for older worlds that are not actively producing new content (Booth, 2009; Clarke, 2014). For the purposes of this research the operational definition of "canon" is:

> Elements of a fictional world that are considered officially part of a specific continuous storyline within one of the world's representations by the owner(s) of the transmedia property.

These research trends have created a void in digital humanities studies, as scholars have been more focused on the themes and metaphors contained within fictional works than how people can interact with and utilize that information. This, combined with the modicum of research done on how people interact with fictional worlds, indicates the need for a properly structured ontology to represent the relationships and information contained within transmedia works and allow people to more easily access their preferred fictional universes.

Importance of Transmedia for Fans/Culture

The role of transmedia in pop culture has been compared to religion, with its devotees, developing mythologies, commitments, and transcendent claims. Transmedia universes have unique rituals, myths, moral codes, clothing, and even holidays. Wagner explains transmedia fandom as a religion that attempts order-making, with "beliefs and imagination spun together into webs of meaning … crafting products that require our participation and invite our devotion" (2012, p. 229). For fans of transmedia, this religion helps them form a human community, focused on human desire, and enter into human relations of exchange. Fans make pilgrimages to mass celebrations at fan conventions, for example, ComicCon, and these equate to ritual gatherings. Attending such events reinforces fans' sense of belonging and allows them to create a community wherein everyone abides by similar rules, expectations, and attitudes towards their fictional universe of choice (Chidester, 2005; Jindra, 1994; Ringlestein, 2013; Wagner, 2012).

The transmedia fan is also more than a consumer of content. They are an interpretive community, one whose existence is aided by the interactivity of Web 2.0, which provides a forum for user-generated content through blogs and social networks, and online-community formation. They are involved in the interpretation of media texts, intensive communication, various cultural practices, and the authoring of their own media content and artifacts within a transmedia fictional "universe" (Sokolova, 2012). The sense of belonging derived from engaging with transmedia provides fans with a means of value-identification, self-development, and opportunity for imaginative creation.

Existing Sources for Transmedia Information

A predominant method for sharing and obtaining transmedia information is using a wiki. A wiki has the benefit of being easy to use and does not require the user to have any experience with website design (Booth, 2009; Wikis, 2006). These pages also have a social component, with discussion spaces where users can discuss or debate elements of their favorite universes (Booth, 2009; Gray et al., 2007; Wikis, 2006; Winder, 2007). Wikis exist for each of the fictional worlds discussed in this paper: Harry Potter,[4] Lord of the Rings,[5] Marvel,[6] and Star Wars.[7]

In 2009 Booth researched how users interact with and use wiki databases that are fan-specific. They found that these fan-created wikis are not only used as sources of shared information and socialization, they are also utilized by fans to create new storylines that adhere to the original canon. Booth describes this as "narractivity" or "the process by which communal interactive action constructs and develops a coherent narrative database." (p. 21).

Although wikis are a useful resource for collaboration and connecting with people who have similar interests, one disadvantage is that they require a large group of active participants and this can lead to an "unwieldy and irrelevant data beast" (Wikis, 2006; Winder, 2007). There can also be a lack of dedicated support to maintaining the webpages, as

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[4]http://harrypotter.wikia.com/wiki/Main_Page
[5]http://lotr.wikia.com/wiki/Main_Page
[6]http://marvel.wikia.com/wiki/Marvel_Database
[7]http://starwars.wikia.com/wiki/Main_Page

well as them becoming useless without people posting and editing content to help the wiki evolve (Winder, 2007).

Beyond this type of information resource, the current situation regarding research and technology for this particular topic is somewhat limited. A few additional resources exist, providing limited information about specific universes, from fan pages created by individuals, such as The Lord of the Rings Encyclopedia of Arda,[8] unofficial fan sites such as Harry Potter Lexicon,[9] and corporate pages such as Disney's Star Wars[10] page and Marvel's[11] site. Our research has yielded no results on the creation of an ontology that reaches across the boundaries of fictional universes. Lucasfilm does have a database similar to our final ontology called Holocron (Clarke, 2014). It contains information and relationships on all things within the official Star Wars canon but remains unavailable to those outside of the company (even those who are expected to create or market text, games, and other artifacts; Clarke, 2014). This closed database further illustrates the need for structured information that is accessible beyond Lucasfilm employees.

In addition, fictional worlds require study because they are full of gaps in knowledge and explicit/implicit facts. As Doležel (1995) argues, a fictional encyclopedia is necessary to organize explicit information and infer connections to elements found in the real world. The model contained herein utilizes structured data and an ontology-based inference engine to identify and represent these connections.

Ontologies for Representing Fictional Universes

Various comic book ontologies are another example of attempts to organize TMFW. However, these tend to be focused entirely on bibliographic information rather than content or elements found within fictional universes. Research by Petiya (2014) focused on creating a system that could convert preexisting comics' metadata into XML and then RDF to utilize said information on the Semantic Web and more easily share resources between libraries. Although these systems may prove useful for the future of this field, they do not assist our current endeavor.

Method

Establishing User Groups

To create an ontology from a user-centered approach, we first aimed to understand who will be using the information represented in the conceptual model by establishing four specific user groups. The model was targeted and developed based on the following four potential user groups: Fan, Scholar, Brand Manager, and Professional Creator; although only the Fan group was used in testing at this point.

Contrary to popular stereotypes, the Fan is typically highly educated (60% have postsecondary degrees);

computer literate; social (80% participate in a fan community); older (30–50 years); highly literate; and intelligent. They also tend to be collectors; create online or in-person communities to socialize or debate with other fans; invest time and effort in writing fan-fiction; and create online resources (e.g., wikis and fan sites; Bondi, 2011; Booth, 2009; Gray et al., 2007).

The Scholar studies transmedia properties to understand popular culture, media communications, history, anthropology, sociology or other social science/humanities-based discipline; and often use domain, citation, and narrative analyses to advance their areas of study (Doležel, 1995; Eco, 2009; Fořt, 2006; Hartshorne, 1987; Hjørland, 2003; Jenkins, 2006; Menard, 2015; Pickard, 2013; Traill, 1991).

The Brand Manager is in the business of transmedia and often works for third-party licensees and has the responsibility of maintaining the continuity of a fictional world across their product lines; they must have access to a data catalog of the fictional worlds' components that they license (Clarke, 2014; Menard, 2015).

The Professional Creator is paid by transmedia property owner(s) to directly create new stories for their fictional worlds; this results in a unique persona that blends both Fan and Brand Manager characteristics. They create new stories in an ongoing world while maintaining canon and are concerned with finding new niches for narratives, which requires them to be able to find and utilize TMFW knowledge (Booth, 2009; Clarke, 2014).

The final product of this research is an ontological model that will suit the information needs of the user groups defined above using an AI engine. To create such a model, this research was done in two phases: develop an initial model by conducting a domain analysis of relevant TMFW (i.e., answer RQ1); and conduct user experience tests to determine how users navigate fictional worlds and interact with the proposed model (i.e., answer RQ2).

Domain Analysis

It is useful to examine existing documents from a domain when trying to understand the structure of information found within it (Hjørland, 2003; Pickard, 2013). We conducted a domain analysis to discover classes, properties, and relationships of narrative elements found within four TMFW. The resulting codes were then generalized to create a preliminary ontological model.

First, we examined a sample of individual stories from comics, books, movies, and television series within four different TMFW. These were selected using the following criteria:

- Multiple independent stories, which contribute to a larger story.
- Narratives found in at least three different types of media.
- Narrative elements that are expected to be found in a fictional world.

TABLE 1. World criteria.

Property	Independent narratives*	Larger narrative	Owner	Example components	Fan artifacts	Genre basis
Star Wars	7 movies 3 TV Series Books Comics Games Theme park attractions Licensed narratives	Narrative canon tightly controlled by Disney/ Lucasfilm Franchise components loosely controlled	Lucasfilm Disney	Characters Events Technology Organizations Family trees Places Vehicles Weapon	Wookiepedia (http:// starwars.wikia. com/wiki/Main_ Page)	Speculative Science Fiction
Harry Potter	7 books 8 movies Theme park attractions Games Website with short fiction	Canon tightly controlled J.K. Rowling	J.K. Rowling Time-Warner	Characters Events Technology Organizations Family trees Places Legal system Magical powers	Harry Potter Wiki (http://harrypotter. wikia.com/wiki/ Main_Page)	Modern Paranormal Fantasy
Marvel	12 movies 8 TV shows 21 Comic books 4 Web shorts Games Licensed narratives	Narrative canon tightly controlled by Disney/ Marvel components loosely controlled	Marvel Disney	Characters Events Technology Organizations Family trees Places Legal system Super powers	Marvel Database (http://marvel. wikia.com/wiki/ Marvel_Database)	Modern Alternative World
LOTR	Dozens of Books 8 Movies Games	Canon tightly controlled by Tolkien estate	Tolkien Estate New Line Cinemas	Characters Events Technology Family trees Places Magical powers Languages	LOTR Wiki (http:// lotr.wikia.com/ wiki/Main_Page)	Epic Fantasy

Note. Facts described are taken from Wikipedia entries for each world.
*At the time of writing.

- Large fan community, as demonstrated by independent fan-created resources that describe the world or contribute to it (Booth, 2009).
- Must be highly familiar to at least one of the researchers (to ease the research process).

As a result, the researchers selected the following four TMFW for analysis: Star Wars; The Wizarding World of Harry Potter; The Marvel Universe; and The Lord of the Rings (LOTR). Table 1 shows how each of these worlds meet the above criteria for study inclusion. These worlds represent diversity in genres (Table 1) and characteristics (Table 2), thus making the analysis more globally representative.

Understanding how genre attributes are applied to popular media helped inform discussion and decisions about how objects, places, and characters in fictional worlds are classified. In turn, these characteristics helped the researchers plot the place of a work in the landscape of genres articulated in media literature. For instance, Marvel's *Thor* takes place partly in the fictional world of Asgard, partly on contemporary Earth, and the character Thor wields a mythical war hammer named Mjölnir that can harness the power of

TABLE 2. Transmedia property characteristics.

Characteristic	Property
Small Number of Mediums	LOTR Harry Potter
Large Number of Mediums	Marvel Star Wars
Large Franchise Components	Star Wars Marvel
Limited Franchise Components	Harry Potter LOTR
Corporate Ownership	Star Wars Marvel
Individual or Estate Ownership	Harry Potter LOTR

lightning. These places, objects, and elemental ability collectively suggest that the genre of *Thor* is fantastic in nature, and is situated someplace within the mythology, fantasy, and superhero genres. The researchers focused on the relationship between these story elements of the media works,

and the genre of fiction in which users might understand the media to belong.

Researchers reviewed various narratives from their assigned TMFW and documented narrative components that described ontological classes, properties, or relationships. This domain harvesting followed the first step in ontology development championed by Wendell Compton (2015). Complete saturation was difficult to obtain because transmedia properties are very large (Jenkins, 2006, 2013; Menard, 2015); instead, each researcher explored the narratives until they believed they were unlikely to find new relevant information, that is, reaching the 90/10 saturation point where researchers were confident that at least 90% of all the elements contained within the transmedia universe were reflected in the codes and that no new information was forthcoming without extreme effort (Martin & Hanington, 2012). Each researcher sampled at least three different types of media and representative content created by the property owner(s), a licensee, or a fan.

Then each researcher used grounded theory (Corbin & Strauss, 1990; Pickard, 2013) to produce their own open coding system. Researchers created and recorded a new code for each element, described it, and included up to five referenced examples. All data were collected in individual spreadsheets and ultimately unified into a single dataset and statistically analyzed.[12] Researchers conducted regular meetings to debrief in an effort to mitigate the potential for divergences in coding.

User Research

The ontological model derived from the domain analysis was then tested by the researchers via usability testing, using a card-sorting technique. Card sorting allowed users to explore the organization of a topic in terms of categories, relationships, and overall organization, and "is considered the traditional route for testing taxonomies" (Soranzo & Cooksey, 2015, p. 35) and for testing the usability of taxonomies such as our ontological model (Martin & Hanington, 2012). The research team followed the traditional in-person testing method outlined by Soranzo and Cooksey (2015), which included (a) planning, (b) preparing the cards, (c) sorting, and (d) analysis.

For the first phase of the card-sort test, the team determined the specific terms within the ontology that would be tested, making it a "closed sort" by only using fixed terms from the ontology and defined samples (Spencer, 2009, p. 82). The team utilized snowball sampling based on the Fan user group to find participants for this study. Spencer notes that "participants often need to ask questions about the content listed on the cards and a good facilitator will need to know enough to clarify" (p. 123); thus, the researchers limited the user study to Fans who likely know the transmedia properties better than other most users, and are the largest

TABLE 3. User study demographics.

Gender	Male: 14	Female: 5		
Age (years)	18–25: 4	26–35: 9	35–45: 6	
Property	H. Potter: 4	LOTR: 4	Marvel: 6	Star Wars: 5

and easiest group to locate. Individuals were identified via: targeted solicitation because they were known to a researcher as a representative of the Fan user group; or through email, social media, or flyers placed in suitable locations. The total sample size was 20 participants. However, one participant was disqualified after revealing they had not read any of the property's materials. Prior research suggests that card-sort studies such as this one typically need 15 participants to be valid (Martin & Hanington, 2012). Participants gave a pseudonym at the time of the interview and data were collected under that moniker and never linked to their real names. Participants gave informed consent verbally and in writing.

For the second phase, that of "preparing the cards," the team created a card set for each transmedia property using 31–34 examples from the domain analysis code sheets, as well as structures from the initial model; each card contained one example from the selected universe. Card sets were designed using a small selection of obvious elements, which would act as a semicontrol group, for comparing and analyzing the participants' understanding of the activity in relation to the themes and relationships being tested in the remainder of each card set, as well as testing their general knowledge of the selected transmedia property (e.g., Smaug the Golden, Mordor, Iron Man, Hero, Villain). Other elements were selected to address questions regarding clarity of language or use. Blank cards and colored tags were also given to the participants for them to write down their own categories, relationships, examples, and/or rationales.

For the third phase, "sorting," researchers each conducted five interviews using the prepared card sets. A few basic demographic and background questions were asked and then the interviewee was asked to sort the cards into logical groupings (Table 3 for demographics). Following that, participants were asked to connect different cards with colored tags to indicate relationships. To minimize interviewers injecting biased feedback into the card sorting activity, interviewers practiced with people not participating in the study to get comfortable with the process prior to conducting real interviews. Interviews were audiorecorded, transcribed, and the resulting card organizations photographed.[13]

Transcripts were analyzed to find areas where the initial model was confusing or the semantics differed from real-world use. Outliers were noted, as they often signify important alternative modes of information-seeking behavior (Martin & Hanington, 2012). These insights were added to the original OWL model developed in the first phase. This included new relationships and structures, as well as

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[12]Detailed statistical analysis can be found in Excel files archived at http://hdl.handle.net/1773/36214

[13]Data are archived at http://hdl.handle.net/1773/36214

updating the semantic labeling of elements to better match common user language.

Discussion

Domain Analysis

The domain analysis of the four TMFWs resulted in a list of unique codes used to organize people, places, and objects significant to the narratives. This analysis gave considerable insight into the correlations and overlapping structures of the domains.

The researchers focused on coding fictional rather than real things. However, during this analysis some real things were identified that were of enough significance within each universe to be included in our coding. An example of this comes from *Iron Man*, as many of the storylines featuring him use real locations (e.g., Afghanistan and New York City). This is an aspect of the final ontology that required special consideration and categorization.

Further analysis revealed additional elements of TMFW that required special attention. For example, characters, places, and objects found in TMFW are often subject to a transformation or metamorphosis of some kind. Some characters change physically, whereas others experience moral or psychological changes that significantly alter their personality and subsequent behavior (e.g., Anakin Skywalker becoming Darth Vader). The catalyst for a metamorphosis was also coded because without it the character, place, or object would not have changed. All properties analyzed had some representation of transformation or metamorphosis. Although, in *Harry Potter*, it was found that these changes were more often a change of perception rather than a true transformation.

Another challenging aspect of these universes is that one can find creative works that only exist within that universe (e.g., *There and Back Again*, by Bilbo Baggins). Fictional folklore, poetry, songs, riddles, and works of art also exist within these worlds. To further complicate matters, a fictional book that is referenced within a transmedia universe may also end up existing in the real world. An example of this is *The Tales of Beedle the Bard*, from the Harry Potter universe. This is a children's book of stories within Rowling's series but also exists as a published work separate from *Harry Potter*.

The domain analysis also revealed a need for the representation of fictional time and calendars to be added to the final ontological model. This problem was similar to the issue of fictionalized places that exist in the real world because there are transmedia universes that use a real calendar system, whereas others have completely new and fictional ways to measure the passage of time; e.g., LOTR's use of "ages" in reference to periods of time that vary in length and conclude due to significant events, such as when the One Ring was destroyed.

These universes have garnered so much popularity that fans frequently create new works that our research classified as "nonlicensed" materials. This type of creation is typically referred to as "fan-fiction" and, in many instances, these stories involve some sort of variation to the characters, places, or things found in that universe. There can also be spoofs, spin-off stories, and remakes that involve variations of these elements. Establishing relationships from these variants to the licensed elements was another challenge in our ontology construction.

Variants were also found within Marvel's licensed materials. These variants were mainly found in rewritten origin stories and movie adaptations of characters. If a comics' character already had one origin story that was then significantly altered with a newer work, the variation also needed to be represented within our ontological model.

The point of saturation was reached with the cumulative code types being: 122 class codes, 46 properties, and 26 relationships. As this was the case for each universe, the domain analysis was complete, and construction of the OWL ontology began. After building the organizational structure and testing its integrity, the researchers moved forward with the user study.

User Research

Interview participants easily categorized the selected control examples in each card set, such as Iron Man as Hero and Darth Vader as Villain. Researchers were able to take these basic relationships and delve into deeper analysis, regarding both specific associations and the differentiation of terms. For example, out of six Marvel card-sort interviews, five participants labeled Iron Man as the Hero and Tony Stark as the Alternate Name or Secret Identity, and participants' thought processes tended to revolve around the superhero being the central character. Researchers had expected the legal/real name to be classified as Hero and the superhero identity to be classified as Alternate or Secret Identity. This labeling applied to other characters, such as Captain America / Steve Rogers, but not to Incredible Hulk / Dr. Bruce Banner and Darth Vader / Anakin Skywalker, which will be discussed later in this section.

The Darth Vader as Villain relationship led participants to distinguish between closely related terms such as *Enemy* and *Villain*, which were included across all four transmedia property card sets. Of the multiple interviewees who spoke to the difference, they generally agreed that an Enemy could be anyone and was dependent on a person's point of view; but a Villain was someone who had evil intent. This argument can be further applied to the general concepts of good and evil, and the need to address character ambiguity, as not all bad characters are evil and not all good characters are heroes. One example from interviews is the character Phil Coulson, who was described positively as Friend four times, but only twice as Hero.

Another example of the difficulties in determining moral alignment is the conflict between the Avengers in Marvel's *Civil War* storyline. One interviewee described the character conflict as being like two candidates of the same political party, and another interviewee described it as "categorizing a category"—the Avengers never stop being in the Hero

category, but the category itself requires a way to distinguish nuances of the heroes it contains. It was determined that the model would need to add or maintain subcategories to address the complex nature of character alignment and, specifically, add Motivations (e.g., anger, fear, or revenge).

Metamorphosis was universally agreed on as a plot-driving element or an event resulting in physical or moral change. In LOTR, one interviewee identified Gandalf fighting a Balrog as the Catalyst for the Metamorphosis to Gandalf the White, and another connected Metamorphosis to everyone corrupted by the One Ring. In Star Wars, one interviewee identified the death of Shmi Skywalker as a Catalyst for the Metamorphosis of Anakin Skywalker to Darth Vader. In Marvel, a Metamorphosis occurred when Dr. Bruce Banner became the Incredible Hulk; however, Steve Rogers or Tony Stark donning their superhero uniform did not constitute a Metamorphosis, because they were still the same person. One interviewee described it this way: Steve Rogers and Captain America are one person in one body; alternatively, the Hulk and Bruce Banner are two people in one body. A similar association was made between Anakin Skywalker and Darth Vader, as multiple interviewees saw them as two distinct characters—the result of a Metamorphosis. This delineation eliminated the Alternate Identity and Secret Identity labels from characters who undergo Metamorphosis, as that change results in an entirely different being.

In Harry Potter, Metamorphosis was identified in Tom Riddle / Voldemort and hesitantly identified as occurring in Severus Snape. All the Harry Potter interviewees had difficulty labeling the changes seen in that character. One person suggested that it was a change in how Snape was perceived, rather than a physical or moral change. Another person suggested that Transformation would be a more accurate term. There is a gap in the research here, as multiple users throughout the interview process suggested the term Transformation as an alternative to Metamorphosis, but researchers did not fully explore how to clearly identify each term's appropriate use, if any. It is clear, though, that Metamorphosis and Metamorphosis Catalyst, as they are labeled by the researchers, were accurately identified as important elements within transmedia worlds.

Several additional findings reinforced the decision to design the model with an emphasis on relationships and properties over classification. Researchers found that when a "thing" has a magical origin it changes from an object to an artifact, such as Thor's Hammer. The relationship between the Emperor and Darth Vader has a distinctly different "tone" than Obi-Wan Kenobi and Luke Skywalker, which requires the application of additional properties beyond the assumed Master/Apprentice and Mentor/Sidekick labels, such as Forced Alliance and Willing Alliance. Researchers also found that elements can be placed in multiple relationships: both Stark Tower and Gryffindor were identified as both Place and Alliance. Using a model based on connections will facilitate further research and provide opportunity for developing end user products.

TABLE 4. Final model components.

Classes	72
Properties	239
Controlled Vocabularies	13
Predefined Terms/Expansion Rules	100

Final Ontological Model

To that end, a final OWL 2.0 model[14] was created using TopBraid Composer[15] and saved in RDF-XML[16] for use. This model was tested by creating example files using the data captured about Iron Man during the domain analysis phase (Table 4 for model components). These tests consisted of using the model with both the TopSpin[17] and JENA[18] AI-reasoners to conduct basic queries about the Marvel Universe. The model was developed using three major design considerations: interoperability with existing relevant ontologies; an emphasis on relationships, as represented in properties, over classes; and capturing the inherent variation that occurs within transmedia properties.

Interoperability

Doležel (1995) particularly noted the importance of making connections between fictional elements in a narrative and their grounding within the real world. This is captured in the final model by ensuring deep integration between it and existing ontologies that represent objects in reality.

This integration was achieved by connecting the properties and classes found in this model to those found in Schema.org ("Schema.org," [n.d.]), The Comic Book Ontology (CBO; Petiya, [n.d.]), Ontology of Astronomical Object Types Version 1.3 (IVOA; Cambrésy, Derriere, Padovan, Preite-Martinez, & Richard, 2010), and SKOS (Miles & Bechohofer, 2009). Classes, such as *Character, Place*, and *Object*, were created as subclasses of the appropriate ones from Schema.org, CBO, and IVOA, thus allowing them to be easily related to real-world *Persons, Planets, Stars, Comics*, and so on (Figure 1). Each was then enhanced with properties that represented their fictional components, such as their connections to the creative works where they are found.

In addition, each of the 13 taxonomies are implementations of a separate SKOS thesaurus (Figure 2). Consequently, management of those controlled vocabularies can be done by simply adding new elements to the defined SKOS schemas.

Finally, in addition to class integration, individual relevant properties within the external ontologies were enhanced with OWL axioms to improve them for use in AI-reasoning engines. Properties, such as *spouse*, can be enhanced to

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[14]Ontology can be found at http://gamer.ischool.uw.edu/Transmedia-FictionalWorldsOntology; the OWL 2.0 specification is at https://www.w3.org/TR/owl2-overview/; and an HTML documentation files can be found in the archived data at http://hdl.handle.net/1773/36214

[15]Project files are located at http://hdl.handle.net/1773/36214

[16]https://www.w3.org/TR/rdf-syntax-grammar/

[17]http://www.topquadrant.com/technology/sparql-rules-spin/

[18]https://jena.apache.org/documentation/inference/

reflect nuances such as arranged marriages and illicit relationships important in fictional worlds. This enhancement is done by creating mirror properties using the *owl:equivalentProperty* mechanism and then enhancing them with axioms and subproperties (Figure 3), thus resulting in a more refined version of *spouse*.

Relationship Focus Via Properties

The integration with external ontologies allowed for a greater focus on the relationships between things over the identification of classes. The user studies revealed that fans preferred making connections between elements versus categorizing them. Consequently, the model has a stronger emphasis on relationships due to its extensive network of properties linking classes together with an average of 3.31 properties per class.

This focus can be shown by looking at how properties from external ontologies have been enhanced to show relationships' tones. Continuing the *spouse* example, the ordinary spousal relationship found in Schema.org is enhanced to account for how official it is. The *spouse* property has a subproperty that separates *lovers* from *officialSpouses*; additionally, a forced relationship can be denoted with *arrangedSpouse* (Figure 3). Finally, the AI engine can infer an *inLaw* property by the use of an *owl:propertyChainAxiom*. This notation chains the *schema:spouse* with *schema:parent* and *schema:sibling* properties. Consequently, an AI-enabled

search engine could infer potential in-laws by simply finding a *Character's lover* and looking up their *parents* and *siblings* using these chains.

In addition to these kinds of enhancements, properties are often linked to union classes (UC). These classes do not represent a single category of things but instead allow the ontology to connect a single type of relationship to many classes of things by declaring the property's domain and range to be a UC, rather than a standard one (Figure 4). For example, an *Organization* or *Place* can be *ledBy* some *Character*. The *ledBy* relationship is not a function of any one of those classes, but could be connected to either one. The use of a UC in these circumstances empowers the AI to focus on the relationship and not the class definition.

Managing Variation Within Transmedia Properties

Finally, elements within a transmedia story will often manifest themselves in different versions across different subnarratives and over time within a single storyline. Each of these variations requires a different solution for representing them to a reasoning engine.

For example, Marvel has the same characters in its Marvel Ultimates series and the Marvel Cinematic Universe. Characters such as Iron Man and Hawkeye appear in both, but have important variations between them such as origin and family backgrounds (Feige & Whedon, 2012; Hickman et al., 2011). To further complicate this, storylines are often recycled between more than one of these worlds. For example, *Civil War* simultaneously exists within Marvel's main comics' canon and the film *Captain America: Civil War* ("Civil War [Comics]," 2016).
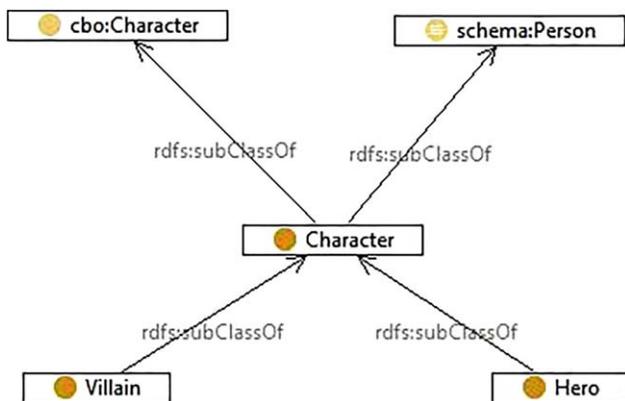

FIG. 1. Example class integration with schema.org and CBO. [Color figure can be viewed at wileyonlinelibrary.com]
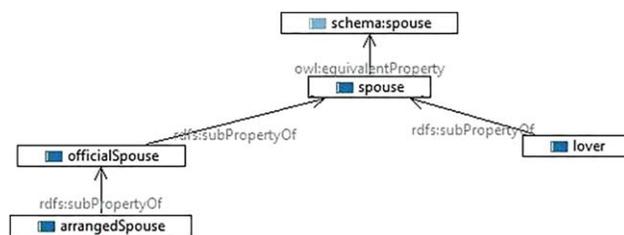

FIG. 3. Property integration example. [Color figure can be viewed at wileyonlinelibrary.com]
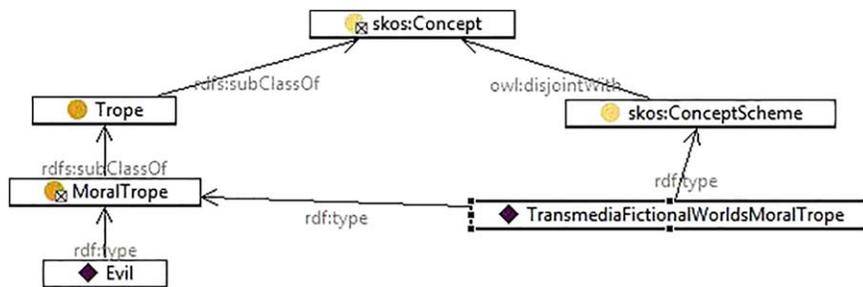

FIG. 2. SKOS integration example. [Color figure can be viewed at wileyonlinelibrary.com]
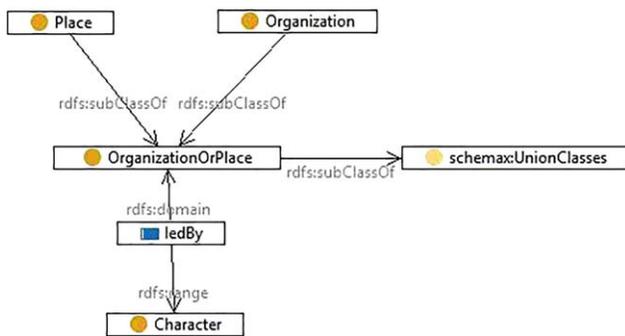
FIG. 4. Relationship using union classes. [Color figure can be viewed at wileyonlinelibrary.com]

The model deals with this kind of variation by connecting different versions of *Things* to the *Transmedia Creative Work* where they appear. It then connects those works to *Transmedia Properties, Story Worlds*, and *Storylines*. *Story Worlds* represent a single consistent canon of work, whereas *Storylines* represent connected works within a single narrative that can be in more than one canon. All of these classes are connected to *Transmedia Property* via a hierarchical web of relationships. This web allows an AI-reasoner to tease out which *Things* are part of what narrative component without each being explicitly declared. The reasoner can do this by tracing the graph's relationships even when they are too complex for a human (Figure 5). For example, the AI can determine that Iron Man is a *fictionalElementOf* the Marvel *Transmedia Property*, Marvel Ultimates *Story World*, and Marvel's *Civil War Storyline* because of his *appearanceIn* the movie, *Captain America: Civil War* and the comics series, *Civil War* #1–7 ("Civil War [Comics]," 2016).

In addition to variations over different narratives, *Things* can change over time as they evolve within a single narrative. These are the kinds of changes that move the plot forward and that the user study revealed are highly important to fans. For example, Tony Stark was not always Iron Man, as he invented the suit due to being captured by terrorists in the movie *Iron Man* (Arad, Feige, & Favreau, 2008).

This variation type is captured with the creation of more than one version of a single *Thing* and connecting them to each other via a *Metamorphosis* event. This event connects the pre-change version to the post-change version of a *Thing*. It can also capture all properties of the *Metamorphosis*, such as what the *catalyst* was for the change, where it happened, who was involved, and what *Actions* it took to make the change happen (Figure 6). For example, Tony Stark had a *Metamorphosis* from a morally dubious playboy to the superhero Iron Man when he was captured by terrorists. All of this information can be structured into data using the model's *Metamorphosis* event.[19]

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[19]The TransmediaFictionalWorldOntology_IronmanExample.rdf file demonstrates the use of a Metamorphosis event and can be found at http://hdl.handle.net/1773/36214

Limitations

A few limitations should be noted regarding our work. The results may not be completely generalizable to all TMFW because of the limited number of worlds examined. We feel this is somewhat mitigated by the diversity of worlds selected. Also, some classes, properties, and/or relationships might not have been found because of both the vastness of TMFW and the limits of guided snowball content sampling. We mitigated this issue by setting a minimum standard of types of sampled content, having each researcher look at a different world, and conducting team debriefs.

There is a reasonable likelihood that geographic bias was introduced into the user study because the research team was only able to interview participants within their local areas. This effect is somewhat mitigated by having a geographically diverse research team working in four different regions.

Finally, we believe the utility of the final model is applicable to the various user groups described above. In this particular work, however, we mainly involved participants from the Fan group during the card sort and interview process. Other user groups may have additional concerns that are not reflected in the current version of the model. We hope to continue to evaluate and revise the model based on feedback from other user groups in our future work.

Future Research and Conclusions

Future research and applications should focus on expanding the model's uses and its applicability, in conjunction with expanding the properties and deemphasizing classes further. Future user studies could investigate the usability of the model and schema with user groups other than Fans, as well as researching how universe size affects the utility of this model. Other options involve how the schema and model could be made more interactive, allowing users to rearrange it to fit their understanding of the universe and terminology; as well as comparing their canon to others' interpretations and the original creator's intentions. Because this research focused on fictional worlds that would be best categorized as science fiction or fantasy genre, additional research is warranted to determine how much of the model is applicable to other genres of TMFW such as mysteries or spy thrillers. A further development of the model could also create a method for exploratory links between the properties and classes of each item within the ontology.

This research set out to discover and develop an ontological model that would address how knowledge is contained within transmedia fictional worlds' (TMFW) narratives (RQ1) and how end users navigate, organize, and understand the information contained within transmedia works (RQ2). By performing a domain analysis on four TMFW, creating a preliminary ontology and AI model, and then performing a user card-sort study, this research has created an ontological model and AI-reasoning program that allows users to investigate and explore various elements of transmedia universes. Our user card-sort study granted us insight
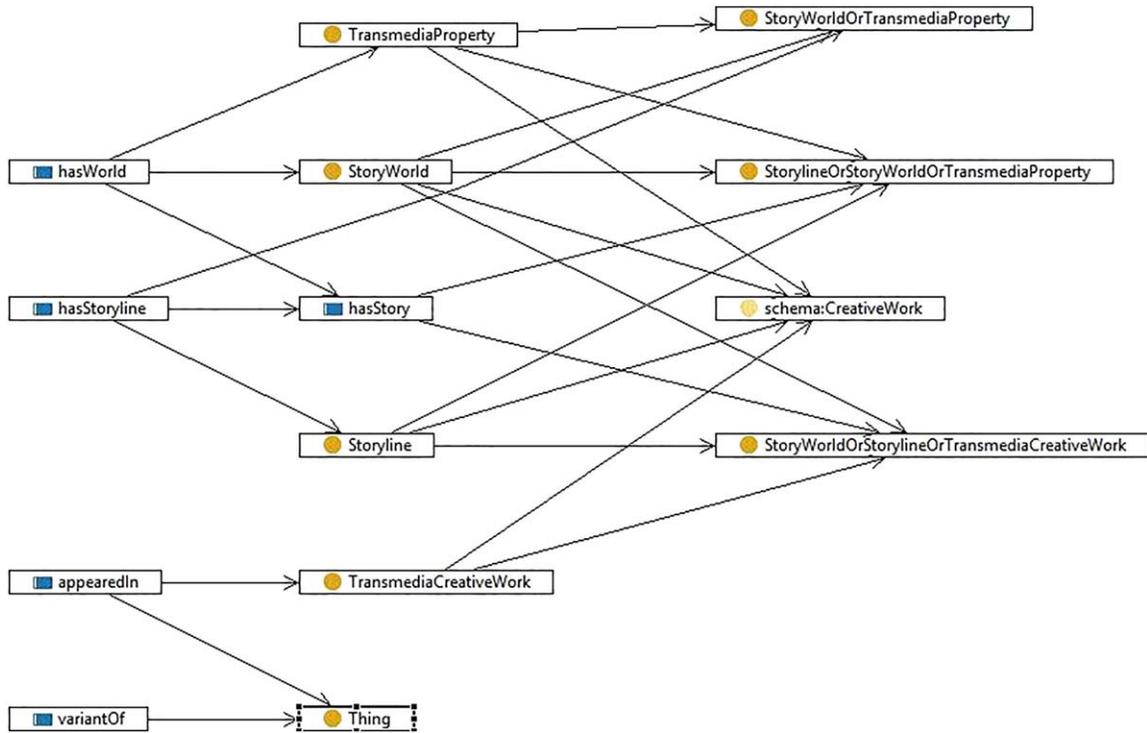
FIG. 5.   Relationships between different types of transmedia creative works. [Color figure can be viewed at wileyonlinelibrary.com]
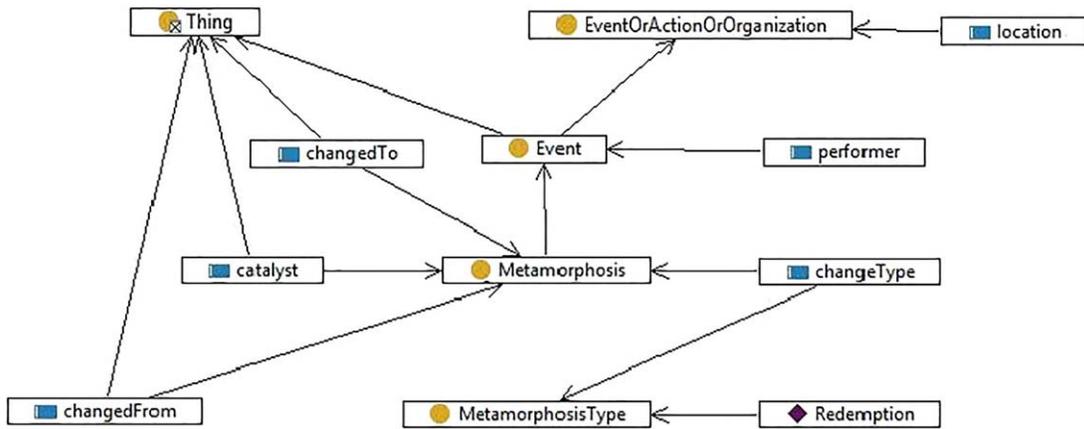

FIG. 6.   Change representation through metamorphosis events. [Color figure can be viewed at wileyonlinelibrary.com]

into users' ideas and prioritization of relationships over categories. This allowed us to further refine the answer to RQ2 and assisted in refining our final model to better organize transmedia knowledge. Both of our initial research questions were answered and even expanded upon during this project. We discovered how knowledge is contained within transmedia narratives and their domain structures, as well as how end users relate to and utilize this information. This ontological model can continue to expand and evolve to meet users' needs for navigating, organizing, and understanding transmedia universes' information as well as furthering the field of digital humanities' studies into these fictional worlds.

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