A Transdisciplinary Approach to Computational Narratology

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Abstract — **The new generation of games searches for in-depth narratives. Innovations in this new trend require a better understanding of interactive narratives based on the emergence of a novel discipline named Computational Narratology. This paper proposes that this new discipline results from the transdisciplinary convergence of concepts and implementation guidance found, among other disciplines, in narratology, database design methodology, and language communication processes.**

Keywords — narratology, transdisciplinarity, communication process, literary theories

I. Introduction

We shall argue in this paper that the *Computational Narratology* discipline [1][2], which draws its concepts and methods from several areas, going from the literary treatment of *Narratology* to the techniques of *Computational Linguistics* and *Database Modeling*, is the result of a *transdisciplinary* convergence of those areas. We shall also show that the existence of analogous concepts, methods, and parallel trends in the contributing areas has been a motivating factor towards the development of the novel discipline.

In one of the most influential inaugural papers, Marc Cavazza and David Pizzi called attention to the two-pronged search of concepts and formalisms for computer implementation:

> Most research in Interactive Storytelling (IS) has sought inspiration in narrative theories issued from contemporary narratology to either identify *fundamental concepts* or derive *formalisms for their implementation*. In the former case, the theoretical approach gives raise to empirical solutions, while the latter develops Interactive Storytelling as some form of "**computational narratology**", modeled on computational linguistics. [bold emphasis added] [1]

and we learn from a comprehensive report coming from a prestigious organization (the American Academy of Arts and Sciences), which recommends *transdisciplinarity* as the most productive approach, that existing concepts found in the contributing discipline should be located and creatively *integrated* to originate new operative concepts, in our case, as we discuss Computational Narratology, able to guide successful implementations:

> The committee concludes that the objective is to achieve transdisciplinarity—to integrate fields beyond the levels of the *multidisciplinary*, in which multiple disciplines operate simultaneously, or the *interdisciplinary*, which occupies the space between disciplines. In the term *transdisciplinary*, the committee sees leveraging of **existing concepts and approaches** from multiple disciplines to **derive new concepts and approaches**, which in turn enable new ways to achieve and utilize understanding. Hence, *transdisciplinary* implies an integration-driven emergence of new disciplines, not just ad hoc collaborations. [bold emphasis added] [3]

Jean Piaget, Erich Jantsch, and André Lichnerowicz introduced the term "transdisciplinarity" at the OECD workshop "Interdisciplinarity – Teaching and Research Problems in Universities" in 1970. Erich Jantsch presented a more elaborate system in 1972 [4]. Basarab Nicolescu edited a book with an overview of theoretical concerns on transdisciplinarity [5]. More recent studies can be found elsewhere [6].

We have a pragmatic view on transdisciplinarity, in that going beyond disciplines requires an in-depth understanding of each knowledge field and the skill to discover hidden connections between concepts through analogies. The main difficulty of the transdisciplinarity practice is the formalism wall, which functions as an impedance to synthesizing new ideas. In the case where computer science should interact with humanities, the barrier is the mathematical formalism of the former. Computational narratology is a perfect example of this problematic situation, where computer scientists reject proposals because formalism sounds too simple, and humanities researchers reject propositions because formalism sounds too specific.

This paper proposes a transdisciplinary view of computational narratology as emerging from analogies between concepts found in narratology, databases, and language communication processes. We avoid getting into the mathematical formalism of database modeling, although we address the proper references for the interested reader.

Computational narratology is essential to any project related to narratives, involving both interpretation and composition. In particular, narratives are vital as the basis of *computer games*, both for entertainment and for serious purposes [7][8]. Interactive storytelling systems intertwine with games, especially today when the new generation of games searches for in-depth narratives. Innovations in this new trend require, however, a better understanding of interactive narratives. And the basis to face this challenge relies on the potentials of computational narratology.

The paper is organized as follows. Section II reviews the literary Narratology three-layer characterization of narratives and proposes an analogy with the three-level methodology of database design, section III shows narrative as one among the components of the communication process, and examines

how competing literary theories elevate each component to a dominant position. In both sections the parallelism of detailed developments and trends in the contributing areas is briefly illustrated. In section IV attention is briefly directed to the distinctive place of games in the literary process, referring to a number of representative games to illustrate the argument. Section V offers concluding remarks.

II. The Three-Layer View of Artifacts

In this section, we exploit the analogy between the three-layer characterization of narratives and the three-level methodology of database design.

A. The perspective from narratology

One of the most influential researchers in Narratology, Mieke Bal, has postulated that the study of narratives should encompass three distinct layers, which she respectively denominates [9]:

1. **Fabula** – a series of logically and chronologically related events caused or experienced by actors.

2. **Story** – a fabula that is presented in a certain manner.

3. **Text** – an artifact in which an agent tells a story in a particular medium, such as language, imagery, sound, buildings, or a combination thereof.

So, fabula constitutes the contents of the narrative, corresponding to *what* is told, whereas story is *how* the fabula is told, and text is the material *form* through which the story is communicated.

From the description of these three layers as a connected sequence, one would assume that it is intended as a universal recipe followed, either consciously or by instinct, by professional or amateurish authors (writers, included), in a strict top-down manner, when composing a narrative. However, Mieke Bal hastens to explain that she is contemplating the readers (casual readers or learned critics), not the authors, and consequently has in mind the reading and *interpretation* activity, rather than composition:

In fact, logically speaking, the reader first 'sees' the text, not the fabula. The fabula is really the result of the interpretation by the reader, an interpretation influenced both by the initial encounter with the text and by the manipulations of the story. And how writers proceed we cannot know. Nor do we need, or even want to. Narrative, the object of study in this book, is a cultural phenomenon, partaking of cultural **processes**. It is the conditions of possibility of those processes that constitute the interest of narrative analyses. To underscore this point more forcefully, I have decided to **reverse** the more traditional order in which the three layers are presented. [bold emphasis added] [9]

In the above quotation we stressed the words '**reverse**' and '**processes**', since we intend to exploit the former in the next subsection and the latter in section III.

B. The computer science perspective

Can we draw some analogy in Computer Science terms between the opposing views – as applied either to composition or to interpretation – of the three-layer proposal presented in section II.A? One possibility is the three-level design methodology in the Database area. The first level specifies classes of entities and their properties, together with rules to establish how the current state can change. For example, in the fairy-tale genre, "creature" has a name and attributes (such as nature, strength, and gender), "Marian is a princess" is a fact, "if the villain is strong, the hero wants to become even stronger" is a general rule, and "try to kidnap" is an operator that causes a state change. The second layer is the logical design that describes how data is structured in tables. The third layer corresponds to the computerized implementation. We present these three layers more precisely as follows:

- **Conceptual design** – initiated by Peter Chen's Entity-Relationship model [10], where the facts that characterize a given real-world domain, i.e. the existing classes of entities and their properties, are specified. As reported in a survey of our previous work [11], we repeatedly dealt with the conceptual treatment of the event-producing operations able to modify the current state by asserting or retracting fact instances, as well as with the goals that motivate the authorized agents to formulate and execute plans, putting together sequences of such operations, in order to reach an advantageous target state.

- **Logical design** – instituted by Edgar Frank (Ted) Codd's Relational Model [12], concerned with a rational way to organize the factual information according to sound theoretical principles, such as normalization, and with logic and algebraic formalisms for managing tabular structures.

- **Physical design** – corresponding to computerized implementation, initially as isolated files and later combining multiple files utilizing one of the several multi-user Database Management Systems (DBMS) then available. These early DBMS products have been classified as pertaining either to the Hierarchic Model or to the more sophisticated Network Model, which was proposed as a universal database standard as a result of the CODASYL project [13], under the leadership of Charles Bachman.

This, indeed, proved to be an especially relevant analogy, as formally demonstrated in [14], wherein we treated the conceptual design of both information systems and narratives through the same logic programming formalism, leading to the *composition* of plots (event sequences) as plans generated under the user's control. The formalism uses the Entity-Relationship model to specify the facts, and the STRIPS method [15] to define the event-producing operations by their pre-conditions and post-conditions.

As to the **reverse** task of *interpretation*, which is in a sense the dual of composition, the applicable analogy in Computer Science is coincidentally called *Reverse Engineering*. Although the soundest strategy in database design is to start from a conceptual specification, too many so-called *legacy systems* still survive, and need to be analyzed via reverse engineering methods, including *Data Mining* and, more recently, *Process Mining* techniques [16], to find the meta-data that categorizes the stored data and the correct or illegal use-cases that have actually occurred, thereby revealing their 'meaning' in real world terms.

A special reverse interpretation task is in order for storytelling purposes when one tries to create new narratives by, essentially, the *reuse* (a notion often exploited in Software Engineering [17]) of narratives found in text format. For instance, to produce an interactive computer-based version

reviving the Cinderella tale, one must first extract the constituent incidents (events) from the old texts [18]. It should be noted that reusing has famously been proclaimed by Roland Barthes to be the usual rather than the exceptional practice:

> We know now that a text is not a line of words releasing a single 'theological' meaning (the 'message' of the Author-God) but a multi-dimensional space in which a variety of writings, none of them original, **blend** and clash. The text is a tissue of quotations drawn from the innumerable centres of culture. [bold emphasis added] [19]

We stressed the word **blend**, anticipating its usage in section III.A as a technical device in the way to reusing narratives for producing novel creative, sometimes even transgressive, variants.

III. THE COMMUNICATION PROCESS METAPHOR

Roman Jakobson [20] proposed a linguistic model of interpersonal communication in which six language factors determine distinct language functions (Fig. 1).
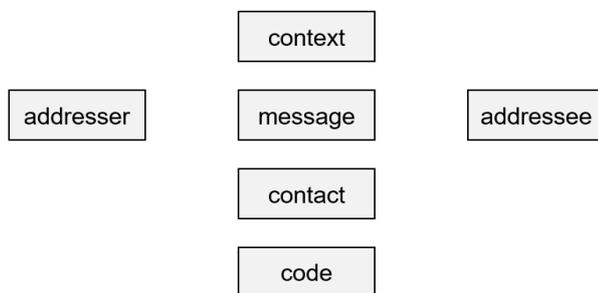
Fig. 1. The communication process.

He explained these constitutive factors or components of any speech event (i.e., in any act of verbal communication) as follows:

> The ADDRESSER sends a MESSAGE to the ADDRESSEE. To be operative the message requires a CONTEXT referred to (the "referent" in another, somewhat ambiguous, nomenclature), graspable by the addressee, and either verbal or capable of being verbalized; a CODE fully, or at least partially, common to the addresser and addressee (or in other words, to the encoder and decoder of the message); and, finally, a CONTACT, a physical channel and psychological connection between the addresser and the addressee, enabling both of them to enter and stay in communication. [20]

Jakobson associated different functions to the components of the process, as shown in Table I.

Discussing these functions is outside the scope of the present paper, inasmuch as we propose to exploit a different assignment, which applies the process communication paradigm to the literary domain, and elucidates, recalling the words of Mieke Bal [9] in the previous section, the extended view of narrative as a "cultural phenomenon, partaking of cultural processes". In this perspective, we propose to associate literary factors to the components of the communication process (Table II and Fig. 2).

TABLE I.   LANGUAGE FUNCTIONS ASSOCIATED TO THE COMPONENTS OF THE COMMUNICATION PROCESS

Component	Language Function
ADDRESSER	emotive
MESSAGE	poetic
ADDRESSEE	conative
CONTACT	phatic
CODE	metalingual
CONTEXT	referential

TABLE II.   LITERARY FACTORS ASSOCIATED TO THE COMPONENTS OF THE PROCESS

Component	Literary Factor
ADDRESSER	author
MESSAGE	narrative
ADDRESSEE	reader
CONTACT	medium
CODE	language
CONTEXT	culture
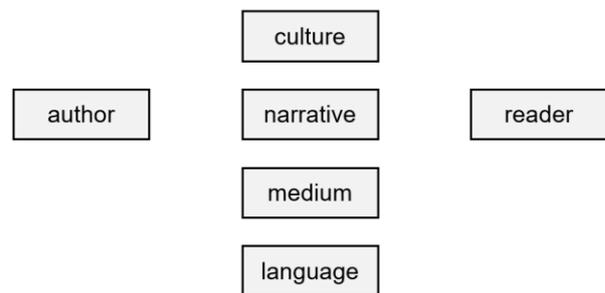
Fig. 2. The literary process based on the communication process.

This view of the literary process can be thus informally summarized: the AUTHOR composes a NARRATIVE (to be consumed by the READER), which reflects an environmental CULTURE, is expressed in a conventional LANGUAGE, and is materialized in some form of MEDIUM.

We shall now examine how competing *Literary Theories* treated these components, in turn privileging each one of them as the appropriate way to explain the *meaning* of literary works. For comprehensive surveys of literary theories see for example [21][22][23][24][25].

A. Sender: the author – Humanistic criticism

When trying to establish the meaning of a text, critics adept of the humanistic tradition [26] (initiated with the revival of the classics of Antiquity during the European Renaissance) would seek to determine the *author's intention*. If not clearly and unambiguously expressed in the text, or in order to achieve a deeper analysis, one could resort, among other sources, to biographical data or to related works of the same or of other authors. For example, to fully apprize what Oscar Wilde told about the life of a prisoner in *De Profundis* and in *The Ballad of Reading Gaol*, one should recall his harsh two years (1895-1897) incarceration with hard labor, and his consequent decision to leave for France and never return to British soil[1].

Semiotics may help us to explain how authors manipulate their life experience and what we saw Barthes calling the innumerable "centres of culture" [19] kept in their memory to

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[1] https://en.wikipedia.org/wiki/Oscar_Wilde

produce their novel compositions. Four kinds of semiotic relations have been proposed [27][11] as instrumental to the production of variants of a given narrative: *syntagmatic* (expressing connection), *paradigmatic* (similarity), *meronymic* (hierarchy), and *antithetic* (opposition). These relations are based on the so-called *four master tropes*, which have been heralded by Jonathan Culler "as a system, indeed the system, by which the mind comes to grasp the world conceptually in language" [28].

Examples of application of the paradigmatic and antithetic relations in the film industry are, respectively, *The Magnificent Seven* [2] (analogous to Kurosawa's *Seven Samurai*) and *The Shape of Water* (where the role of the monster of *Creature from the Black Lagoon*[3] is inverted so as to become the winning protagonist). Still in the film industry, examples of the meronymic relation are given in the direction of summarization by trailers and of specialization by the extraction of scenes – consider, for instance, relative to *The Devil's Advocate*, its trailer[4] and the Al Pacino's devil speech scene[5].

In the fairy tale genre, the syntagmatic relation can explain the making of the Grimm brothers' *Little Red Cap* tale as a concatenation of the earlier Perrault's version [29], which ends with the sad fate of the girl and her grandmother, and the tale of *The Wolf and the Seven Little Kids*, also present in the Grimm's collection [30], which inspires the rescue episode. But we cannot fail to notice that, to concatenate the two original tales, a crucial change was needed in the villainy scene: instead of *eating* its two victims, which would cause their irretrievable death, the wolf merely *swallowed* them, so that they could be extracted alive from its belly. This change is an excellent example of *blending*, a word that we found and stressed at the end of the previous section.

Blending gains a special importance whenever the automatic search and reuse of previous problems to find solutions to new ones is considered. This search constitutes the objective of the *Case-based Reasoning* techniques [17], which start with a pattern-matching phase to locate the previous similar cases, and then proceeds to *adapt* them – which is a far more complex task – to the new circumstances. For this task, one must consult the seminal research on blending, discussed in [31] by Fauconnier and Turner, and given a formal treatment by Goguen in [32].

Besides relying on the authors' circumstances to establish textual meaning, humanistic critics such as Matthew Arnold, Henry James and F. R. Leavis, elected the most celebrated authors, a chosen list of 'Classics', as canons to be reverently cultivated in courses devoted to the English language [21]. In the early days, when there were no personal computers and programs were only understood by their *authors*, the professional *programmers*, those especially trained persons were regarded as a species apart from the 'casual users' (whose elevation to a dominant role was an objective of the Relational Model innovation [12]). At that time, introducing a novelty like the substitution of ordinary isolated files by sophisticated databases required an appeal to programmers – who should train themselves to *navigate* through physical *pointers* in the multi-file network described by Bachman [33]. Curiously enough, 'navigation' became fashionable again in

the Internet world announced by Berners-Lee [34], now along uncountable *links*, and requiring the preparation of both specialists and, to a considerable extent, of any person. Increasing co-participation of users in the authorial work is today a current trend, fostered by the advent of *interactive* systems, with a strong impact on digital storytelling [35].

B. Message: the narrative – New Criticism

Blaming the humanistic approach as subjective and non-essential, and discounting it as a fallacy [36], the proponents of New Criticism called the critics' attention to the texts themselves as the sole bearers of meaning. Obscure passages, ambiguities, and all kinds of interpretation difficulties should all be faced through the *close reading* of the narrative. This attitude is remindful of the universal jurisprudence concentration on the letter of the law (*mens legis*) rather than on the legislator's alleged intentions (*mens legislatoris*) when interpreting a law [37].

In the Software Engineering discipline, the notion of close reading corresponds to the concern with *program correctness* [38], the need to verify in detail, regardless of the programmer's claims, what a piece of software effectively does and whether that is what it was supposed to do.

Even though the New Criticism attack against arbitrary subjectivity might be justified, it should be remarked that abstaining from considering, among other factors, the authors' personal experience, was an alert applicable to the work of critics and to university courses directed at the *interpretation* of the narratives. When dealing with the *composition* of narratives, the relevance of such factors should not be discounted, as has been argued here in the Oscar Wilde case. And today there are university courses aiming at training narrative composition; in a recent offering of such courses, it was announced that students will specifically learn "how to write into the known and unknown chapters of their ancestry, and will write creatively in response to their readings[6]."

On the other hand, the efforts of New Criticism to deal with language and stylistic craftsmanship are of prime importance, and are seconded by the ongoing work in *Computational Linguistics* [39][40], aiming at both natural language textual *recognition* and *generation*, two among the most difficult tasks in Digital Entertainment projects.

An unanimously acclaimed Canadian scholar helped operating a transition from this productive North American tradition to an emerging, considerably more formal-oriented, European current. Indeed, Northrop Frye, listed by Terry Eagleton [21] among the adepts of New Criticism, started like them with an erudite analysis of an individual work, namely William Blake's poems, but ten years later produced a major collection of essays of a much broader scope [41]. In view of this later work of enormous influence, Eagleton commented that [21]: "There is a loose sense in which Northrop Frye's work can be described as 'structuralist', and it is significantly contemporary with the growth of 'classical' structuralism in Europe." In that work, to the question whether there are "narrative categories of literature broader than, or logically prior to, the ordinary literary *genres*?", Frye responds: "There are four such categories: the *romantic*, the *tragic*, the *comic*, and the *ironic* or *satiric*" [41].

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[2] https://en.wikipedia.org/wiki/The_Magnificent_Seven
[3] https://en.wikipedia.org/wiki/The_Shape_of_Water
[4] https://www.youtube.com/watch?v=40hHA9n4C2o

[5] https://www.youtube.com/watch?v=RGR4SFOimlk
[6] https://class-descriptions.northwestern.edu/4820/WCAS/ENGLISH/39275

Such categories [41], associated with 'mythoi' named after the seasons of the year, indicate four possible relationships between the protagonist and the world around. In *comedy* (associated with the mythos of spring), the world is benign, and the protagonist is *accepted* as soon as has adjusted to its social rules and conventions. In *romance* (summer), the world is still benign but needs the protagonist's action to recover from a crisis through a *victorious quest*. In *tragedy* (autumn), the world is dominating and unforgiving, and the protagonist is destined to *succumb*, as punishment (*nemesis*) for arrogant pride (*hybris*). In *satire/irony* (winter), the world has reached a grotesque, totally absurd condition, to which the protagonist *opposes*, often hopelessly.

Phases of crisis, victory, defeat – the ups and downs of the protagonist's fate – are adequately modeled by *story arcs*, originally sketched in a rejected master's thesis of Kurt Vonnegut, and later developed [42] to become a thematic feature in digital storytelling projects [43].

C. Code: the language – Structuralism (and Post-Structuralism)

The Swiss linguist (and semiologist) Ferdinand de Saussure distinguished two language levels: 'langue' and 'parole' [44]. The former referred to the synchronic *structural* description of some natural language, whereas the latter referred to a specific utterance, a given poem or novel for example. Inspired by his work, a growing number of scholars, inaugurating the *Structuralism* theories, attempted the structural characterization of genres, thus expanding the meaning of 'langue', to encompass the genre conventions. An early accomplishment was Vladimir Propp's seminal morphology of Russian fairytales [45].

Our own method of composition, mentioned at section II.B, employing repertoires of predefined sets of operations to handle a given literary genre (as well as a business application domain, such as banking) which obeys the *Abstract Data Types* paradigm [46], is entirely analogous to Propp's usage of a set of 31 *functions* to describe narratives in the folktale genre, whose *types* and *motifs* have been catalogued in the Aarne-Thompson comprehensive *Index* [47].

When looking for sound theoretical formulation of composition methods, it is appropriate to resort to overarching metasciences. Besides Semiotics, we have looked at Mathematical Logic, especially *Situation Calculus* [48], wherein a second-order logic treatment of event-producing operations, defined as we do by pre-conditions and post-conditions, is postulated. Such definitions lead to the use of backward-chaining planners, able to convert narrative plot composition into a plan-generation problem [14].

Now, planners are ideal to simulate a newly specified system, so as to make sure that the specification effectively permits all authorized use cases, while forbidding any illegal or, for some motive, undesirable cases. Planners are such a precious asset because it is hard indeed, even for the most experienced designers, to predict what can result from the interplay of even a moderately large set of rules. Once we thought that we had given to our planner an impossible goal: a knight K1, weaker than the villainous dragon, would have to kill it, and we added that the knight would insult the magician who would, if approached courteously, fill him with extra power. The planner immediately responded: another knight

K2 fought for some time against the dragon with no result except tiring the adversary and thus reducing its strength; with that, the weak K1 was strong enough to kill the dragon – and after that he proceeded to insult the magician.

The price to pay is the exponential complexity of general planners, unavoidably compelled to examine an unlimited number of useless alternatives. A practical option is to begin by running the planner to generate a suitable collection of useful plans, and/or extracting from the execution Log a number of typical transactions repeatedly executed by the users – and then to treat plans and transactions as *traces*, to be articulated under some form of workflow, *Petri nets* [49] being one of the preferred choices in *Process Mining* applications [16]. The workflow format reduces the allowed execution paths to a manageable number.

The Structuralism agenda suffered a later revision by *Post Structuralism* proponents, like Roland Barthes, Michel Foucault and the psychologist Jacques Lacan, initiating a less self-confident trend. As remarked by Culler [22], "They recognized the impossibility of describing a complete or coherent signifying system, since systems are always changing". More radically, analysis by Derrida's notion of *deconstruction* [50][28] menaced the dogmatic construction of meaning. To give an oversimplistic example, consider the movie *Shane*, which purports to be an apology of non-violence, but would fail to attract the audience if it did not reach its climax in a violent showdown shooting scene[7].

Arguably, the work of other scholars, who do not appear to follow any literary theory, can also be included as contributions to the definition of narrative structure. Prominent among these contributions are narrative *patterns*, such as Joseph Campbell's heroic *monomyth* [51], complemented by Vogler's guidance to prospective writers [52], derived from Campbell's Jungian account of the initiation and progress of heroes.

D. Receiver: the reader – Reader-Response Theory

Running the risk to return to subjectivity, literary critics such as Wolfgang Iser [53] turned their attention to the reader, affirming that it was in each reader's mind that a narrative was completed. Naturally, they imagined 'model readers', not inferior to writers in world knowledge and reasoning ability.

Indeed, a new concern with subjectivity, now doubled by considering the mind of the author vis-à-vis the potentially very different minds of readers, would seem an unavoidable consequence of an intriguing alternative to the reassuring dyadic 'signifier-signified' correspondence preached by Saussure [44] and adopted by Structuralism. This alternative is the triadic 'representamen-interpretant-object' notion of *sign*, proposed by the North American scholar Charles Sanders Peirce [54], who forms, together with Saussure, the pair of founding fathers of Semiotics.

Roughly speaking, the representamen is akin to Saussure's signifier, it is the *form* taken by the sign; the object is, like the signified, *what* is referred to by the sign, something existing in a real or fictional world; and the interpretant – Peirce's major innovation – would be the *sense* produced in somebody's mind by the sign. The notion of interpretant implies the presence of individual *interpreters*, i.e. human subjects such as authors and readers, who do not necessarily

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[7] https://en.wikipedia.org/wiki/Shane_(film)

construe the same sense in one given narrative. Such line of reasoning, in turn, raises a problem: how can authors hope to somehow harmonize their intended sense with that of their readers, if this is at all possible?

Umberto Eco, sensitive to Peirce's influence, talked in special of 'open works' and 'works in movement', i.e. works that deliberately left decisions on the meaning of certain passages to the care of the reader. In [55], he explained how authorship could be shared between author and reader, the latter assuming the role of **performer**:

> Therefore, to sum up, we can say that the "work in movement" is the possibility of numerous different personal interventions, but it is not an amorphous invitation to indiscriminate participation. The invitation offers the **performer** the opportunity for an oriented insertion into something which always remains the world intended by the **author**. [bold emphasis added] [55]

A crucial point is that the author does not lose control of his work. Although the exact course of the assemblage in each different mind may take unforeseen turns, the alternative possibilities open to the reader as performer would have been built into the work, 'rationally organized, oriented, and endowed with specifications for proper development':

> In other words, the author offers the interpreter, the performer, the addressee a work to be completed. He does not know the exact fashion in which his work will be concluded, but he is aware that once completed the work in question will still be his own. It will not be a different work, and, at the end of the interpretative dialogue, a form which is his form will have been organized, even though it may have been assembled by an outside party in a particular way that he could not have foreseen. The author is the one who proposed a number of possibilities which had already been rationally organized, oriented, and endowed with specifications for proper development. [55]

Eco's open work agenda, barely viable in written texts, clarifies in a very nice way what is feasible today in the various forms of *interactive storytelling*, games included, wherein the author-performer partnership is fully executable. An author is always assumed, one or more persons who conceive and implement a software piece, to be offered to users who will run it, making decisions whenever the storyline reaches a *branching point*. The final resulting plot will in all justice deserve to be perceived by the user – in the *performer* role – as a personal new creation.

The user-as-performer role is enhanced in games that invite the player to assume the identity of some character. To allow someone to act simultaneously as user, performer and, from this point on, as *avatar*, the game must have been equipped with a *testing* feature, that will assess certain psychological traits to determine the degree of involvement that the person would be willing to accept, which character to impersonate, and the behavior to be expected at the storyline branching points. To this end, the *big five* (OCEAN) test has been applied, and calibrated with the help of Artificial Intelligence techniques (typically *neural networks*), to fit the game parameters to the person's observed attitudes [56].

Interactive storytelling plots occurring in games have been classified by Marie-Laure Ryan [35] into three categories, according to the underlying narrative: *epic*, *dramatic* and *epistemic*, this third category (not anticipated by Aristotle) referring to mystery and detective stories. According to another most influential classification, due to Roger Caillois [57], the game narrative will convey some or all the following basic types of experience: *agon* (competition), *alea* (luck), *mimicry* (impersonation), *ilinx* (vertigo). Among these, competition seems to be indispensable, indeed implied by the very definition of game. On the other hand, vertigo, intolerable to many people, is surely indispensable in serious games designed to instruct airplane pilots, in which they must be exposed to disturbances accompanying emergency situations while prompt decisions are demanded.

The growing emphasis on the reader, noticed in the literary area, runs parallel to a compelling *trend* in computer systems design to value *usability* as a fundamental requirement. A sign of this trend is the recognition that expertise in *Human-Computer Interaction* [58] is indispensable to produce artifacts that human beings have no difficulty to handle, meet their expectations, and effectively satisfy their needs.

E. Channel: the medium – Media Theories

Each medium has its own distinct requirements. Working on interactive digital storytelling prototypes, our group started with animation for visual presentation. When we decided to try a more advanced option of recording video sequences with real actors, and arrange the scene transitions in a harmonic way, we realized that this choice of medium required the employment of *cinematography* techniques [59][60].

It would appear that the choice of a medium to 'implement' a narrative would exclusively be a concern at what narratology scholars calls the text level [9]. Yet this is not so – different media call for different ways of presentation, a scene that looks fine in a book may look clumsy in a movie. Indeed, the required adaptations to pass from a medium to another may propagate up to the fabula level, affecting the narrative plot itself. One detective tale of Agatha Christie provides a patent case – consider the differences between the *Evil under the Sun* original written tale[8] and its rendering in film, starred by David Suchet[9].

Media as a technological conquest, independently from the contents transmitted, gained special attention in consequence of Marshall McLuhan's statement that "the medium is the message" [61]. The scholar's argument is that the everyday habits of entire populations are impacted when a new medium becomes available, as happened with television and, more radically, with the Internet [34], with, among other effects on all sorts of individuals, the urge to express themselves in *social media*[10]. And the popularity of games should be included as another obvious effect. Deep considerations on this theme gave origin to *Media Theory* proposals [62].

The simultaneous usage of different media is the object of an active trend, *Transmedia Storytelling*, which "represents a process where integral elements of a fiction get dispersed systematically across multiple delivery channels for the purpose of creating a unified and coordinated entertainment experience"[11].

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[8] https://en.wikipedia.org/wiki/Evil_Under_the_Sun
[9] https://agathachristie.fandom.com/wiki/Evil_Under_the_Sun_(Agatha_Christie%27s_Poirot_episode)

[10] https://en.wikipedia.org/wiki/Social_media
[11] http://henryjenkins.org/blog/2007/03/transmedia_storytelling_101.html

F. Context: the culture – Ideologies of Revolt

What narratives are told and how they are told very much depends on circumstances of time and place, so that different cultures produce different narratives, often in an attempt to justify what Jonathan Culler calls the "discursive practices and the institutions of the period" [22]. But, still as noted by this scholar, the current dominant discourse keeps provoking the advent of contrary subversive narratives, under the stimulus of a flurry of literary theories, such as [22]: *New Historicism*, *Cultural Materialism*, *Feminism*, *Marxism*, *Post-Colonial Theory*, *Minority Discourse*, and *Queer Theory*. A description of each of these ideologies of revolt would run outside the scope of the present paper.

We shall limit ourselves to one example of the influence of conflicting political orientations on how the same bare incidents (at the *fabula* level) were differently assimilated (at the *story* level, through the intermediacy of what Schank called 'skeletons', a notion seemingly derived from his earlier notion of 'scripts') to be finally expressed at the *text* level, by speakers from antagonistic world powers [63]:

> **The bare facts** (*fabula* level):
>
> A few years ago the United States Navy shot down an Iranian airliner carrying over 200 passengers. Let's look at some different stories that were constructed to explain this event. All the stories that follow are excerpts from various New York Times reports in the days following this incident:
>
> **Versions** (*text* level, based on different skeletons at the *story* level):
>
> **Mr. Reagan** smiled and waved at tourists as he returned to the White House. But in speaking to reporters he remarked on what he had previously called "a terrible human tragedy. I won't minimize the tragedy," Mr. Reagan said. "We all know it was a tragedy. But we're talking about an incident in which a plane on radar was observed coming in the direction of a ship in combat and the plane began lowering its altitude. And so, I think it was an understandable accident to shoot and think that they were under attack from that plane," he said.
>
> After expressing "profound regret" about the attack, **Mrs. Thatcher** said: "We understand that in the course of an engagement following an Iranian attack on the U.S. force, warnings were given to an unidentified aircraft. We fully accept the right of forces engaged in such hostilities to defend themselves.
>
> **Libya's official press agency** called the downing "a horrible massacre perpetrated by the United States." It said the attack was "new proof of state terrorism practiced by the American Administration" and it called Washington "insolent" for insisting that the decision to down the plane was an appropriate defensive measure.
>
> **A newspaper in Bahrain**, Akhbar Al Khalij, said: "No doubt yesterday's painful tragedy was the result of Iran's insistence in continuing the Iran-Iraq war. The United States as a great power does not lack moral courage in admitting the mistake. This will help contain the effects of the accident."

At the *story* level, Reagan's *text* version would have been, according to Schank, motivated by a commonly used **understandable tragedy** skeleton:

1. actor pursues justifiable goal

2. actor selects reasonable plan to achieve goal

3. plan involves selection of correct action

4. action taken has unintended and unanticipatable result

5. result turns out to be undesirable

6. innocent people are hurt by result

7. it is not the actor's fault

To cope with emotional variations in texts, computerized analysis methods are available [64], which deal with the expression of sentiments in natural language and are able to sort out conflicting opinions.

IV. THE LITERARY PROCESS IN GAMES

Narrative design for games offers additional challenges for story writers. While in a traditional literary process writers are the solo authors of the narrative, in games this responsibility is shared among a variety of game development professionals, such as designers, artists, and programmers. This responsibility is also extended to players, who will be in charge of shaping the final narrative according to their choices and actions. Therefore, writing for games should induce the author to understand that the reader is a player with motivations related to the gameplay (solving puzzles, pursuing achievements, progressing though the game). As stressed by Maggs, game narratives must "provide a context (a game world) and incentive (reward) for gameplay" [65].

Game narratives can be structured in a variety of ways, including linear stories (e.g. *God of War* series (2005-2018), *Call of Duty* series (2003-2020), *Final Fantasy* series (1987-2020)), carefully crafted branching storylines (e.g. *Mass Effect 2* (BioWare, 2010), *The Witcher 3: Wild Hunt* (CD Projekt RED, 2015), and *Cyberpunk 2077* (CD Projekt RED, 2020)), and open-ended structures that focus on providing the player with a sandbox whereupon narratives can be built (e.g. *The Sims* series (2000-2021), *Minecraft* (Mojang Studios, 2011)). This range of different narrative manifestations within the medium highlights the different approaches used by game developers to design narratives, but also the heterogeneity of the narrative phenomenon in games [66].

Dramatic structures, such as the three-act structure [67] and the hero's journey [51], are commonly used by writers and designers in the process of crafting compelling and interesting stories for games. Although these structures were originally proposed as a way to represent the structure of a dramatic linear work, such as a play or film, the new entertainment media has been applying classical dramatic structures for non-linear interactive media [68][69].

The three-act structure is recurrent in the plot of many successful games. This well-known dramatic structure consists in dividing the narrative into three acts: Act One – Setup (1/4 of the story time), Act Two – Confrontation (2/4 of the story time), and Act Three – Resolution (1/4 or less of the story time). As any well-written novel, play, or film, most games start Act One by introducing the characters, so the player becomes familiar with the setting. An example is the prologue of *Red Dead Redemption II* (Rockstar Studios, 2019), where the player meets the main characters of the gang while crossing the snowy mountains and setting up camp in

the deserted mining town of Colter (Fig. 3). It is also in Act One that the player usually meets the antagonist (or at least the problem created by the antagonist). The same happens in *God of War* (Santa Monica Studio, 2018), when Kratos is confronted by a mysterious man with godlike powers (later identified as Baldur – the Norse Aesir God of Light). Act One also includes an "inciting incident", where the protagonist is challenged to overcome a problem; and includes an even more dramatic situation, known as the "first plot point", which results from the protagonist's attempts to deal with the inciting incident. Another example is *Fallout 4* (Bethesda Game Studios, 2015), where the player is confronted with a nuclear attack (the inciting incident) that forces his family to take refuge in a vault where they are frozen in cryogenic tubes. This incident leads the story to its first plot point: while frozen in the cryogenic tube, the player's avatar impotently watches two strangers murder his wife and kidnap his son (Fig. 4).

Fig. 3. Arthur Morgan (controlled by the player) and Dutch van der Linde explore the area after setting up camp in the mining town of Colter (Red Dead Redemption II, Rockstar Studios, 2019).

Fig. 4. The player's avatar watches two strangers murder his wife and kidnap his son through the window of a cryogenic tube (Fallout 4, Bethesda Game Studios, 2015).

Act Two is where most games truly shine by allowing the player to engage in a series of challenges. While completing these challenges, the protagonist will learn new skills and attain a better sense of awareness about himself and the world around him, which will be essential to defeat the antagonist. For example, during Act Two of *God of War* (Santa Monica Studio, 2018), the player explores the Lake of the Nine, travels across different realms, and upgrades the Leviathan Axe and the Blades of Chaos, which are crucial to continue the adventure. At the same time, more story elements are revealed: Atreus discovers that his father Kratos is a god, Freya's and Baldur's familial relationship is revealed, and the player learns about the immortality spell that was cast on Baldur.

The final act of the three-act structure features the resolution of all the conflicts that were presented in the story.

The climax is the main event of Act Three and it is where the emotional tension of the narratives reaches its most intense point. It is in Act Three that the player can put all personal skills to the test in a final confrontation. For example, in *God of War* (Santa Monica Studio, 2018), the climax is represented by the final fight against Baldur (Fig. 5). After the climax, the tension decreases as the final events of the narrative are presented. In the denouement of *God of War*, Kratos and Atreus travel to Jötunheim, where they find a temple with their adventures depicted on the walls. By spreading the ashes of Atreus's mother at the highest peak of Jötunheim, Kratos and Atreus fulfill their promise and complete their main quest.

Fig. 5. Kratos defeats Baldur (God of War, Santa Monica Studio, 2018).

In games with branching storylines, authors usually apply a dramatic structure to all possible storylines that can emerge from the different player decisions. Such happens in *Fallout 4* (Bethesda Game Studios, 2015), which has four different endings. After discovering that his son, Shaun, is the Institute's director, the player may decide to join the Institute, betraying the Brotherhood of Steel and Railroad factions. In this case, the final battle is against the betrayed factions (the climax of Act Three). Otherwise, if the player refuses to join the Institute, the only possible next choice is to side with one of the factions to a final nuclear fight against the Institute.

Although the three-act structure can be found in many successful games, there are also games that adopt more specialized narrative structures. For example, the plot of *The Witcher 3: Wild Hunt* (CD Projekt RED, 2015) matches a specialized structure called "The Fall and Rise of the Grail Hero" [70], which places emphasis on the hero's recovery (*rise*) after acquiring the knowledge whose lack was the cause of an initial failure (*fall*). In this specific case, the initial failure occurs when Geralt of Rivia fails in defeating the Wild Hunt at the battle of Kaer Morhen. The hero's recovery occurs in the end of the game when Geralt and Ciri defeat Eredin and the Wild Hunt (Fig. 6).

Although games may borrow thematic and structural elements from traditional literary works, the dynamic and mutable nature of games offers some unique forms of interaction between authors and audience. While traditional story writers can only rely on the average preferences of their audience, game writers can make use of variables that can only be assessed during the game, such as individual player preferences and behaviors, to create more satisfying and personalized experiences. In this context, player modeling techniques have been used for the construction of computational models of players [71], which includes models to describe cognitive [72][73], affective [74][75][76], and behavioral [56] characteristics.

Fig. 6. Geralt of Rivia defeats Eredin (The Witcher 3: Wild Hunt, CD Projekt RED, 2015).

Player modeling has been an active research topic since the 90s, and many AAA games became known for adopting player oriented techniques, such as *Silent Hill: Shattered Memories* (Konami, 2009), which dynamically creates a personality model of the player (Fig. 7) and uses it to adapt gameplay and narrative elements; and *Left 4 Dead* (Valve, 2008), which uses player modeling to graduate the difficulty of the game's challenges in response to the player's actions.

Fig. 6. A therapist asks the player to fill a personality test (Silent Hill: Shattered Memories, Konami, 2009).

V. CONCLUDING REMARKS

The gist of this paper is the realization that *Computational Narratology* results from the *transdisciplinary convergence* of concepts and methods from diverse disciplines to originate new concepts and implementation guidance, not a mere collaborative effort of specialists.

We concentrated on three major paradigms, one coming from the area of literature, the second from database modeling, and the other from linguistics, namely the *three-layered composition/ interpretation view* of narratives, the *three-level methodology of database design*, and the *communication process metaphor* that integrates narratives into a larger perspective. Along the discussion we examined a number of detailed comparisons, showing how narrative features became tractable in digital interactive storytelling thanks to already existing concepts, methods and trends coming from Computer Science disciplines. Finally, the unique place of game narratives in the literary process thus far discussed was briefly outlined and illustrated by way of a few representative games.

We do not claim, of course, to have covered all relevant parallels. The reader will promptly come up with many others. In Computer Science alone, games need contributions from Artificial Intelligence, Computer Graphics, Database, Multimedia Interface, Image Processing, Computational Vision, and Data Science. We must also acknowledge that our choice of topics was inevitably biased by what resources we have been utilizing in our ongoing project.

Future work is needed to deepen this study, one topic of particular interest being to examine how varying cultural elements can diversely affect the narratives underlying serious and fictional games.

REFERENCES

[1] M. Cavazza and D. Pizzi, "Narratology for Interactive Storytelling: A Critical Introduction," in Proceedings of the 3rd International Conference on Technologies for Interactive Digital Storytelling and Entertainment, 2006, pp. 72-83, doi: 10.1007/11944577_7.

[2] I. Mani, Computational Modeling of Narrative - Synthesis Lectures on Human Language Technologies. Williston, Vermont, USA: Morgan & Claypool Publishers, 2013.

[3] ARISE II, "Unleashing America's Research & Innovation Enterprise," American Academy of Arts and Sciences, 2013.

[4] E. Jantsch, "Inter- and transdisciplinary university: A systems approach to education and innovation," Higher Education, vol. 1, pp. 7-37, 1972.

[5] B. Nicolescu, Transdisciplinarity: Theory and Practice. New York, USA: Hampton Press, 2008.

[6] D. Fam, L. Neuhauser, and P. Gibbs, Transdisciplinary Theory, Practice and Education. Springer International Publishing, 2018.

[7] M. O. Riedl, "Interactive Narrative: A Novel Application of Artificial Intelligence for Computer Games," in Proceedings of the Twenty-Sixth AAAI Conference on Artificial Intelligence, Toronto, Canada, 2012, pp. 2160-2165.

[8] E. Naul, and M. Liu, "Why story matters: A review of narrative in serious games," Journal of Educational Computing Research, vol. 58 (3), pp. 687-707, 2020, doi:10.1177/0735633119859904.

[9] M. Bal, Narratology. Toronto, Canada: University of Toronto, 2002.

[10] P. Chen, "The Entity–Relationship Model – Toward A Unified View of Data," ACM Transactions on Database Systems, vol. 1 (1), pp. 9-36, 1976, doi: 10.1145/320434.320440.

[11] A. L. Furtado, and N. Ziviani. "Information and data management at PUC-Rio and UFMG," in Proc. of the VLDB Endowment, 2018, pp. 2114-2129.

[12] E. F. Codd, "A Relational Model of Data for Large Shared Data Banksm," Communications of ACM, vol. 13 (6), pp. 377-387, 1970.

[13] A. Metaxides et al., Data base task group report to the CODASYL programming language committee. New York, USA: Association for Computing Machinery, 1971.

[14] A. Ciarlini, M. A. Casanova, A. L. Furtado, and P. Veloso. "Modeling interactive storytelling genres as application domains," Journal of Intelligent Information Systems, vol. 35 (3), 2010, pp. 347-381.

[15] R. E. Fikes, and N. J. Nilsson, "STRIPS: A New Approach to the Application of Theorem Proving to Problem Solving," in Proceedings of the International Joint Conference on Artificial Intelligence (IJCAI), London, UK, 1971, pp. 189-208, doi: 10.1016/0004-3702(71)90010-5.

[16] W. van der Aalst, "Process Mining," Communications of the ACM, vol. 55 (8), pp. 76-83, 2012, doi: 10.1145/2240236.2240257.

[17] J.L. Kolodner, "An Introduction to Case-Based Reasoning," Artificial Intelligence Review, vol. 6, 1992, doi: 10.1007/BF00155578.

[18] S. Kawakami, Y. Sato, M. Nakagawa, and B. Indurkhya, "On modeling conceptual and narrative structure of fairytales," in Proceedings of the European-Japanese Conference on Information Modelling and Knowledge Bases (EJC), Kitakyushu, Japan, 2003.

[19] R. Barthes, "The Death of the Author," in Image-Music-Text, S. Heath (ed.). New York, USA: HarperCollins Pub. Ltd., 1993.

[20] R. Jakobson, "Linguistics and Poetics," in Twentieth-Century Literary Theory, K.M. Newton (ed.). London, UK: Palgrave Macmillan, 1997.

[21] T. Eagleton. Literary Theory – an Introduction. The University of Minnesota Press, 2003.

[22] J. Culler, Literary Theory – a Very Short Introduction. Oxford, UK: Oxford University Press, 2000.

[23] H. Bertens, Literary Theory - the Basics. Oxfordshire: Routledge, 2002.

[24] R. Selden, P. Widdowson, P. Brooker, A Reader's Guide to Contemporary Literary Theories. London, UK: Pearson, 2005.

[25] M. Klages, Literary Theory – a Guide for the Perplexed. London, UK: Bloomsbury Publishing, 2015.

[26] M. H. Abrams, "What is a Humanistic Criticism," Journal of Literary Criticism, vol. 8 (2), 1996.

[27] E. S. Lima, B. Feijó, M. A. Casanova, A. L. Furtado. Storytelling Variants Based on Semiotic Relations. Entertainment Computing, v. 17, p. 31-44, 2016.

[28] J. Culler, The Pursuit of Signs: Semiotics, Literature, Deconstruction. Oxfordshire, UK: Routledge, 1981.

[29] E.S. Lima, A. L. Furtado, B. Feijó, "Storytelling Variants: The Case of Little Red Riding Hood," in Proceedings of the IFIP International Conference on Entertainment Computing, Trondheim, Norway, 2015, pp. 286-300.

[30] J. Grimm, and W. Grimm, Grimm's Complete Fairy Tales. San Diego, California, USA: Canterbury Classics, 2011.

[31] G. Fauconnier, and M.Turner. "Conceptual projection and middle spaces," Technical Report 9401, University of California, 1994.

[32] J. Goguen, "An Introduction to Algebraic Semiotics, with Application to User Interface Design," in Computation and Metaphor, Analogy and Agents. C. Nehaniv (ed.). Springer-Verlag, 1999.

[33] C. Bachman, "The Programmer as Navigator," Communications of the ACM, vol. 16 (11), pp. 653-658, 1973, doi: 10.1145/355611.362534.

[34] T. Berners-Lee, Weaving the Web: The Original Design and Ultimate Destiny of the World Wide Web. New York: Harper Business, 2000.

[35] M. Ryan, "Interactive Narrative, Plot Types, and Interpersonal Relations," in Proceedings of the Joint International Conference on Interactive Digital Storytelling (ICIDS), 2008, pp. 6-13.

[36] W. K. Wimsatt, and M. C. Beardsley, "The Intentional Fallacy," The Sewanee Review, vol. 54 (3), 1946.

[37] E. E. Triantafilou, "Contemporaneity and Evolutive Interpretation under the Vienna Convention on the Law of Treaties," ICSID Review - Foreign Investment Law Journal, vol. 32 (1), pp. 138-169, 2017.

[38] E. A. Ashcroft. Program correctness methods and language definition. In Proceedings of ACM Conference on Proving Assertions about Programs, 1972.

[39] R. Mitkov, The Oxford Handbook of Computational Linguistics. Oxford, UK: Oxford University Press, 2005.

[40] A. Clark, C. Fox, and S. Lappin, The Handbook of Computational Linguistics and Natural Language Processing. Hoboken, USA: Wiley-Blackwell, 2013.

[41] N. Frye, Anatomy of Criticism. Princeton University Press, 1973.

[42] A. J. Reagan, L. Mitchell, D. Kiley, C. M. Danforth, and P. S. Dodds, "The emotional arcs of stories are dominated by six basic shapes," EPJ Data Science, vol. 5, 31, 2016, doi: 10.1140/epjds/s13688-016-0093-1.

[43] E. S. Lima, B. Feijó, and A. L. Furtado, "Procedural Generation of Quests for Games Using Genetic Algorithms and Automated Planning," in Proceedings of the XVIII Brazilian Symposium on Computer Games and Digital Entertainment, Rio de Janeiro, Brazil, 2019, pp. 495-504.

[44] F. Saussure, Course in General Linguistics. R. Harris (trans.). Chicago, USA: Open Court, 1998.

[45] V. Propp. Morphology of the Folktale. L. Scott (trans.). Eastford, USA: Martino Fine Books, 2015.

[46] J. Guttag, "Abstract Data Types and the Development of Data Structures," Communications of the ACM, vol. 20 (6), 1977.

[47] A. Aarne, and S. Thompson, The Types of the Folktale. Helsinki, Finland: Acad. Scientiarum Fennica, 1961.

[48] R. Kowalski, and F. Sadri, "Reconciling the Event Calculus with the Situation Calculus," Journal of Logic Programming, Special Issue: reasoning about action and change, vol. 31 (1-3), pp. 39-58, 1997.

[49] J.L. Peterson, "Petri Nets," Computing Surveys, vol. 9 (3), pp. 223–252, 1977, doi: 10.1145/356698.356702.

[50] J. Derrida, Writing and Difference, A. Bass (trans.). Chicago, USA: University of Chicago Press, 2017.

[51] J. Campbell, The Hero with a Thousand Faces. Princeton, USA: Princeton University Press, 1973.

[52] C. Vogler, The Writer's Journey. Studio City, California, USA: Michael Wiese Productions, 2020.

[53] W. Iser, The Act of Reading: A Theory of Aesthetic Response. Charles Village, Baltimore, USA: Johns Hopkins University Press, 1980.

[54] C.S. Peirce, Collected Papers. C. Hartshorne, P. Weiss, A.W. Burks (eds.), Harvard University Press, vols. 1-8, 1921-1958.

[55] U. Eco, The Open Work. A. Cancogni (trans.). Cambridge, USA: Harvard University Press, 1989.

[56] E.S. Lima, B. Feijó, A. L. Furtado, "Player Behavior and Personality Modeling for Interactive Storytelling in Games," Entertainment Computing, vol. 28, pp. 32-48, 2018.

[57] R. Caillois, Men Play Games. M. Barash (trans.). Illinois; USA: University of Illinois Press, 2001.

[58] M. G. Helander, Handbook of Human-Computer Interaction. North Holland, 2014.

[59] E. S. Lima, C. T. Pozzer. M. C. d'Ornellas, A. E. M. Ciarlini, B. Feijó, and A. L. Furtado, "Virtual cinematography director for interactive storytelling," in Proc. of the International Conference on Advances in Computer Entertainment Technology, Athens, Greece, 2009, pp. 263-270.

[60] E. S. Lima, B. Feijó; and A. L. Furtado, "Video-based Interactive Storytelling Using Real-time Video Compositing Techniques," Multimedia Tools and Applications, vol. 77 (2), pp. 2333-2357, 2018.

[61] M. McLuhan, Understanding Media. The Extensions of Man, Cambridge, USA: MIT Press, 1998.

[62] A. J. L. C. Canán, "McLuhan, Flusser and the Mediatic Approach to Mind," Flusser Studies, vol. 6, 2008.

[63] R. C. Schank, and R. P. Abelson, "Knowledge and Memory: The Real Story," in Knowledge and Memory: The Real Story, R.S. Wyer, Jr (ed). Mahwah, New Jersey, USA: Lawrence Erlbaum Associates, 1995.

[64] B. Liu, Sentiment Analysis and Opinion Mining. San Rafael, California, USA: Morgan & Claypool Publishers, 2012.

[65] B. Maggs, "The Writer Between: Thieving Literary Plot to Design Game Narrative," in Proceedings of the 21st Annual Conference of the Australasian Association of Writing Programs, 2016.

[66] J. Bizzocchi, and T. J. Tanenbaum, "Mass Effect 2: A Case Study in the Design of Game Narrative," Bulletin of Science, Technology & Society, vol. 32 (5), pp. 393-404, 2012.

[67] J. Yorke, Into The Woods: How Stories Work and Why We Tell Them. London, UK: Penguin, 2014.

[68] B. Ip, "Narrative Structures in Computer and Video Games: Part 1: Context, Definitions, and Initial Findings," Games and Culture, vol. 6 (2), pp. 103-134, 2011, doi: 10.1177/1555412010364982.

[69] B. Ip, "Narrative Structures in Computer and Video Games: Part 2: Emotions, Structures, and Archetypes," Games and Culture, vol. 6 (3), pp. 203-244, 2011, doi: 10.1177/1555412010364984.

[70] E. S. Lima, A. L. Furtado, B. Feijó, and M. A. Casanova, "Towards Reactive Failure-Recovery Gameplaying: The Fall and Rise of the Grail Hero," in Proceedings of the XV Brazilian Symposium on Computer Games and Digital Entertainment, São Paulo, Brazil, 2016, pp. 262-271.

[71] G. N. Yannakakis, P. Spronck, D. Loiacono, and E. André, "Player Modeling," Dagstuhl Follow-Ups, vol. 6, 2013.

[72] A. Nagle, P. Wolf, and R. Riener, "Towards a system of customized video game mechanics based on player personality: Relating the Big Five personality traits with difficulty adaptation in a first-person shooter game," Entertainment Computing, vol. 13, pp. 10-24, 2016.

[73] M. P. Silva, V. N. Silva, and L. Chaimowicz, "Dynamic Difficulty Adjustment Through an Adaptive AI," in Proceedings of the XIV Brazilian Symposium on Computer Games and Digital Entertainment, Teresina, Brazil, 2015, pp. 173-182.

[74] E. S. Lima, B. Feijó, and A. L. Furtado, "Adaptive Storytelling Based on Personality and Preference Modeling," Entertainment Computing, vol. 34, 100342, 2020, doi: 10.1016/j.entcom.2020.100342.

[75] E. S. Lima, B. Feijó, A. L. Furtado, and V. M. Gottin, "Personality and Preference Modeling for Adaptive Storytelling," in Proceedings of the XVII Brazilian Symposium on Computer Games and Digital Entertainment, Foz do Iguaçu, Brazil, 2018, pp. 538-547.

[76] E. S. Lima, B. Silva, and G. Galam, "Towards the Design of Adaptive Virtual Reality Horror Games A Model of Players' Fears Using Machine Learning and Player Modeling," in Proceedings of the XIX Brazilian Symposium on Computer Games and Digital Entertainment, Recife, Brazil, 2020, pp. 171-177.