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Labyrinth 3D. Cultural archetypes for exploring media archives

Since the advent of the World Wide Web, online media archives have changed their audience from a restricted number of professionals and amateurs to the general public. This shift is not without consequences: if, on the one side, it represents an important opportunity for archives to engage in a dialogue with a larger audience, on the other side it advocates novel forms of access that go beyond the highly specialized models underlying traditional access tools.

In this paper, we propose to use 3D graphics for designing novel tools of exploratory search in cultural heritage archives. Our approach has been deployed as an online virtual environment where the user can navigate the meaning relations over the items in the archive. Targeted at cultural heritage, the application, called here Labyrinth 3D, relies on the use of cultural archetypes to inform the conceptualization of the archive and the creation of the virtual environment, with the goal of engaging the user in the exploration of the archive through the creation of personal paths.

Keywords: media archives, 3D environments, exploratory search, cultural heritage, archetypes

1. Introduction

In the last decades, the advent of the World Wide Web has led public institutions and private actors (the latter also known as creative and cultural industries - CCI), to publish their media archives online, dramatically increasing the range of cultural contents that are available to the general public. Online digital archives innovate the access of cultural resources (Bolick, 2006, Haskins 2007, Beer & Burrows 2013), advocating new forms of curation and access to cope with what has been called the "data deluge", generated by the digitalization process and the advent of born digital data (Hey and Trefethen 2003, Beagrie 2008). The rich variety of online imagery, text, and other

1
2
3 resources raise new challenges to the traditional paradigm of archive access, stimulating
4
5 novel and interactive methods that culminate with the emergence of "archive inspired"
6
7 creativity. For example, the artist Shimon Attie (Popescu 2012) creates multimedia art
8
9 installations where archive materials such as film footage and pictures become part of
10
11 an immersive audience experience; similarly, the work "Were the house still standing",
12
13 designed by a multi-disciplinary team of artists, photographers and sound designers, is a
14
15 multimedia installation about the Holocaust, which incorporates archival recordings and
16
17 images into a poetic storytelling (Katz and Quin 2012).
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22 As noticed by Chen et al. (2005), the openness of digital archives implies the
23
24 coexistence of different user perspectives over the archive contents, ranging from the
25
26 historical and archaeological stance to the iconographical and cultural one. In order to
27
28 support multiple perspectives in the access to the archives, Chen et al. propose the
29
30 insertion of an explicit "abstraction layer" into the architecture of the digital archive, to
31
32 acknowledge the relevance of the conceptual models employed by the users in the
33
34 interpretation of the archive contents.
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38 In this paper, we join Chen et al.'s notion of abstraction layer with the paradigm
39
40 of archive-based creativity by proposing "cultural archetypes" as conceptual tools that
41
42 support the construction of personal paths through digital archives. Inspired by the
43
44 research in iconology (Van de Waal 1974, Warburg and Birnk 2008), literature (Highet
45
46 1949) and narratology (Thompson 1955), we employ the term 'archetype' to refer to a
47
48 conceptual core set at the intersection of narrative motifs, iconological themes and
49
50 classical mythology. Common examples are the archetypes of "journey", "labyrinth",
51
52 and "hero": deeply rooted in collective consciousness, as stated by C. G. Jung (1981)
53
54 and enforced by the practice of imitation in Western Culture, these archetypes possess
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1
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3 the unique capability to create a multiplicity of links over heterogeneous resources
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5 within shared, unifying conceptual models.
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8 In our proposal, the cultural archetype motif deploys an online exploratory
9
10 environment through the selection of one virtual archetype that inspires the design of a
11
12 graphic dynamic interactive interface, and the organization of a number of archetypes -
13
14 collected after the study of the archive -, for the design of the user interaction. In
15
16 particular, the graphic interface is a realization of the well known archetype of the
17
18 *labyrinth*, introduced by the myth of the Minotaur but retrievable even in contemporary
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20 culture (e.g., J.K. Rowland's Harry Potter's novel about a "goblet of fire", where a
21
22 tournament is partly held in a hedge maze) and spanning distant geographical locations
23
24 (from, e.g., Cnossos Palace in the island of Crete to the city of Reims in France, where a
25
26 well-known labyrinth is represented in the cathedral). As surveyed by Kern (2000),
27
28 different realizations of the archetype of the labyrinth span worldwide across ages,
29
30 ranging from the representations provided by ancient civilizations all across Europe to
31
32 the mazes created in the last century, with mirrors and hedges, for entertainment (for
33
34 example, the well known hedge maze in Hampton Court). The virtual environment, that
35
36 we will term Labyrinth 3D in this paper, has been designed with the goal of supporting
37
38 the archetype-based exploration of media archives: the user is immersed in a 3D maze,
39
40 where the locations, corresponding to archive items, are connected through pathways
41
42 created dynamically, following the meaning relations that are inferred automatically in a
43
44 computational ontology of archetypes. Turning point after turning point, the user
45
46 decides where to direct her/his exploration, based on her/his curiosity about the
47
48 categories of the archetypes ("character", "story", "action", "object", "place", and
49
50 "epoch") represented in the ontology. As she/he advances in the maze, following
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3 personal choices driven by the preferences for the archetypal category, a path emerges,
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5 connecting distant items.,
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8 This paper is structured as follows: after describing the motivations and
9
10 requirements accounted for in the system design (Section 2), we illustrate the sources of
11
12 inspiration that informed its design (Section 3) and how they eventually shaped the
13
14 implemented system (Section 4). The description of the system abstracts from technical
15
16 details to focus on the user experience, that we describe through a navigation example.
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18 An account of the feedback received from the audience (Section 5) and the conclusion
19
20 end the paper.
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28 29 **2. Background motivations and functional requirements**

30 The digital convergence that has recently affected the access to cultural heritage
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32 and the distribution of media objects brings content producers and consumers to share
33
34 and generate contents, working alongside the traditional paths of cultural markets and
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36 education (Jenkins 2006). In the access to cultural heritage, digital convergence has
37
38 favoured the development of digital platforms, such as online museums and cultural
39
40 websites, aimed at encouraging the approach of the general public (consider, for
41
42 example, the well known Europeana web portal¹). Notwithstanding the disruptive
43
44 potential of the convergent culture, however, the access to digital media archives is still
45
46 largely based on keywords and/or tags, through which the users can filter contents to
47
48 find what they need. Personalization and integration with social networks have been
49
50 exploited to innovate the relationship of the archives with the audience, but the basic
51
52 access paradigm has not changed yet. Rather, the research has focused on the design of
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¹ www.europeana.org

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3 effective search tools, integrated by personalization and recommendations, without
4 affecting the general framework depicted above, which is based on formally specified
5 queries. As a result, a change of paradigm in archive exploration has not been
6 accomplished yet: the access to online archives still relies, in most cases, on the
7 metaphor of the traditional archive, where a collection of physical items are described in
8 a catalogue by subject, title, etc., and the access to them is obtained by searching
9 various indexes implemented on the catalogue. A search in a digital archive normally
10 returns a list of relevant objects (books, pictures, videos, etc.), without an explicit
11 representation of the meaning relations over them, with the exception of from spatial
12 and temporal representations such as maps and timelines. The advent of the Semantic
13 Web can compensates for this lack, but the complexity of relations encoded in the
14 formal languages of the Semantic Web may exacerbate the presentation issues.
15
16 Pioneering attempts have been made at using different type of conceptual categories to
17 describe archive contents: for example, the Agora project (Van Den Akker et al. 2011)
18 describes artworks in terms of the historical events they refer to; the Decipher project
19 relies on a story ontology to support the creation of "museum narratives" (i.e., story-
20 based collections of artworks) by curators (Mulholland et al. 2012). The access to
21 digital collections, however, still relies on traditional metaphors that replicate a physical
22 equivalent, such as the archive or the museum.
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49 Our proposal relies on three main premises.

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52 The first premise concerns the inadequacy of search based tools to the needs of
53 the general public, recently pointed by Hall (2014): in most cases, people approach an
54 archive without a specific set of items in mind - or, even worse, without a specific set of
55 constraints to form their queries. According to Hall, access tools should specifically
56 support the exploration of the archives by the users: the notion of *exploratory search*
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3 (Marchionini 1996), characterized by serendipity, is especially suitable to the needs of
4 non professional users, who approach an archive without any specific search goals in
5 mind, but with the simple desire to explore its contents. In our proposal, the key to the
6 access is the notion of archetype: this notion provides an explicit *abstraction layer* for
7 archive access, open to the creation of personal paths through the contents, and
8 identifies the specific archetype of the labyrinth to devise a spatial metaphor for
9 supporting the exploration task in a virtual space.
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22 The second premise concerns the tradition of organising cultural artefacts along
23 thematic categories based on their historical, geographical and iconographical features,
24 whose importance is emphasized by the multidisciplinary perspective of digital
25 convergence (Trant 2008). This practice not only underpins the use of timelines, maps,
26 and advanced visualizations in online digital archives, but brings with it the established
27 use of spatial layouts to convey categories. Consider, for instance, the use of spatial
28 layouts in cultural spaces, such as exhibitions and museums, to create thematic sections
29 and paths (Hillier & Tzortzi 2006). Our approach adapts this paradigm to the
30 exploration of archives: we propose an especially designed, virtual environment that the
31 users explore to access the contents of the archive through the archetypal visual
32 metaphors of the labyrinth, with the causal and associative relations over the contents
33 represented by a maze of physical connections.
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53 The third premise concerns the use of visual technologies, employed in today's
54 applications that range from video games to edutainment and installation art, and
55 capable of providing immersive, engaging user experiences (LaViola & Keefe 2011).
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60 The use of 3D for data visualization relies on the process described by Manovich

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3 (2011), by which the properties of the digital medium, through the use of specific
4
5 software for editing, sharing, and analyzing digital data, shape the actual content to be
6
7 conveyed: 'all 'properties of digital media are now defined by the particular software as
8
9 opposed to solely being contained in the actual content' (p 30). However, these
10
11 properties by themselves do not ensure the reception of the intended conceptualization:
12
13 as argued by Ziemkiewicz -Kosara (2008), based on their empirical studies, the choice
14
15 of the visual metaphor is crucial to communicating a conceptual model to the users, that
16
17 goes beyond the properties of the medium. Moreover, Rieber & Noah (2008) show that
18
19 a carefully designed balance of visual and game elements in educational applications
20
21 provides a more effective transmission of the notions to the users. Here, 3D
22
23 visualization is put to use for engaging the audience in the exploration of data through
24
25 the archetypal element.
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35 **3. Inspirational works**

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37 The conceptual model encoded in Labyrinth 3D is inspired by the notion of
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39 cultural archetype, set at the intersection of categories of prominently narrative nature,
40
41 namely character, story, action, object, place, and epoch. Stories provide an effective
42
43 conceptual model for mediating between the user and the description of the cultural
44
45 artefacts, thanks to the relevance of narrative cognition for the transmission of cultural
46
47 values (Bruner 1991). The content of visual artworks, in particular, can often be
48
49 described in terms of some narrative situation, i.e., a basic template where a character is
50
51 depicted in the intentional act of doing something, using some instrument, as part of the
52
53 achievement of some goals that characterize her/him. An example of the role of
54
55 narrative templates in iconography is provided by Iconclass (Van de Waal, 1974), a
56
57 thesaurus of subjects employed to classify art objects according to their iconographic
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1
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3 content: with more than 4000 occurrences of story-related categories, Iconclass includes
4
5 specific categories of narrative nature, such as classical mythology. The reference to
6
7 narrative entities, then, is not limited to visual artworks, but extends across media and
8
9 genres, ranging from music to novel (Almén 2003, Ryan 2004), further propagated by
10
11 the practice of remediation (Bolter & Grusin 2000).
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17 A notable reference is provided by Warburg's Mnemosyne project (1929). The
18
19 core of the Mnemosyne project (Warburg and Birnk 2008) is a set of iconographical
20
21 archetypes (a pictorial atlas, or *BUILDERATLAS*), described through tables (*pathosformeln*)
22
23 where different images are collected to describe some kind of archetypal concept. For
24
25 example, table 4 of Warburg's *BUILDERATLAS*, which describes the topic of the relationship
26
27 between gods and mankind, combines two classical heroes, Prometheus and Phaeton, by
28
29 virtue of their challenges to the gods. Despite the intrinsic limitations posed by the
30
31 historical, cultural, and political factors that affected Warburg's selection of subjects
32
33 (Bruhn 2000), the approach of Mnemosyne to the exploration of culture can be seen as a
34
35 precursor of the paradigm of "exploratory search" advocated by the advent of online
36
37 cultural heritage archives.
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46 Figure 1

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49 Figure 1: *Pathosformeln* from Warburg's *BUILDERATLAS* (www.engramma.it).
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51

52
53 Similarly to the *BUILDERATLAS*, where the juxtaposition of iconographic references
54
55 suggests implicit relations among artefacts across ages and media, in Labyrinth 3D the
56
57 user navigation is driven by an archetype that associates artefacts of different type,
58
59 represented by digital objects. The exploration obtained through the archetypes
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1
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3 leverages the sparseness and multiplicity of the meaning associations yielded by the
4
5 archetype along each category (character, story, action, object, place, and epoch) to
6
7 provide serendipity to the user navigation.
8
9

10 In particular, the archetype of the labyrinth, deeply rooted in Western Culture
11 (Kern 2000), lends itself well to conveying the many-to-many relations among the
12
13 cultural heritage objects established by the collection of archetypes employed in the
14
15 projects, thanks to its graph-like nature (Rosenstiehl 1971, 1988). The metaphor of the
16
17 labyrinth trades off the use of spatial layouts for orientation against the unpredictability
18
19 of the environment that characterizes it, providing at the same time the immediacy of
20
21 use that is typical of well-known environments. In Labyrinth 3D, the representation of
22
23 the physical layout of the space, usually employed as a tool to orientate the user (i.e.,
24
25 with top down views and maps), is employed in a first-person view to create a sense of
26
27 disorientation. However, disorientation here is not without a purpose, since it acts as a
28
29 stimulus for the user to discovery, in a serendipic way, the heritage treasures hidden in
30
31 the maze, and to consider (or even re-consider), the relations over them. Differently
32
33 from maps, the exploration in Labyrinth 3D takes the form of a subjective, creative
34
35 experience so as to provide a sense of enactment as the walk of the user through the
36
37 maze proceeds.
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45 Despite the inner organization of the archetypes into categories, the nature of the
46
47 archetype belongs to the realm of *liquid design*, in the sense established by Novak since
48
49 his first theorization of liquid architectures (1991). As exemplified for the aural domain
50
51 by the installation "Allobrain", described by Thompson et al. (2009), the use of today's
52
53 immersive 3D technologies enables the creation of liquid architectures into virtual
54
55 environments where users "create their own trajectories" through the object domain. In
56
57 Labyrinth 3D, the fluid nature of the notion of archetype does not enforce curatorial,
58
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1
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3 predetermined "visit paths", but lets trajectories through the archive emerge from the
4
5 interaction of the user with the virtual environment. The metaphor of the labyrinth, then,
6
7 is also visually characterized by fluidity (Deleuze 1983), thanks to the plurality of
8
9 perspectives it creates onto the domain of observation.
10
11

12 13 14 15 16 17 **4. Labyrinth 3D**

18
19 In this section, we describe the implemented environment Labyrinth 3D², where
20
21 the archetype of the labyrinth gives shape to the 3D virtual immersive environment and
22
23 a set of cultural archetypes, each organized along the categories "story", "character",
24
25 "epoch", "object", "action", and "place", mediate the user exploration of a repository of
26
27 media resources. Briefly, the 3D environment consists of a virtual labyrinth that
28
29 contains digital representations of the items in the archive, linked by pathways that
30
31 represent the archetypal similarities among them. Targeted on the general audience, the
32
33 project aims at encouraging the users to explore the media repository, as a way to
34
35 promote personal cultural enrichment and cultural heritage dissemination. Labyrinth is
36
37 not targeted on a specific type of heritage or media: the assumption underlying the
38
39 project is that cultural archetypes, due to their pervasive nature, can be employed as a
40
41 compass to help the user navigate heterogeneous repositories.
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50 51 **4.1 Design and User Experience**

52
53 The setting of the environment is inspired to the classical hedge maze, with
54
55 architectural elements that are intended to remind some distant but not well specified
56
57 past, so as to prepare the user to the appearance of disparate and temporally distant
58
59
60

² url omitted for blind review

1
2
3 items. This choice was due to the constraint posed by the heterogeneity of the items in
4
5 the archive, which share connections with the same archetype though being different for
6
7 appearance, style, epoch, etc., and for its similarity to the "gothic" genre usually
8
9 featured by the maze games many users are familiar with. Maze games, originally
10
11 characterized by 2D graphics, like Atari's Pacman³, are a well-established genre,
12
13 recently proposed in 3D graphics with bestselling titles such as Imangi's Temple Run⁴
14
15 (one of the most downloaded apps for iPhone in 2013⁵) or PlayFirst's Dream Chronicles
16
17
18
19
20
21 ®⁶.

22 In Labyrinth 3D, the floor is partly tiled, partly covered with grass, reminiscent
23
24 of a deserted location that is seldom visited, so that the user gets the feeling of
25
26 undertaking a solitary journey in an abandoned area - as the accidental, sparse,
27
28 somehow "lost in memory" nature of the connections induced by the archetype
29
30 suggests. The environment includes two types of elements, namely nodes and pathways
31
32 connecting the nodes. Pathways differ in length and form: some are shorter and let the
33
34 user catch a glimpse of the destination; some are longer and bend, so that their end is
35
36 not visible before the user gets near the end. Small differences in the visual appearance
37
38 of the nodes and pathways embellish the environment, serving at the same time the
39
40 function of allowing the user to remember the elements visited so far, useful in case of
41
42 backtracking (without Ariadne's thread!), or in case the user finds her/himself in a
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51
52 ³ <http://en.wikipedia.org/wiki/Pac-Man>

53
54 ⁴ <http://www.imangistudios.com>

55
56
57 ⁵ Josh Constine (January 15, 2012). "Mobile Game Design: How Evil Monkeys Chased Temple
58
59 Run To App Store #1". TechCrunch. Retrieved May 18, 2015

60
⁶ <http://www.playfirst.com/games/view/dream-chronicles>

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2
3 location that she/he has already visited before - a not unusual situation in mazes that is
4
5 purposely allowed for by the design of the environment.
6
7

8 Nodes include nodal spaces, where artworks are located, and crossroads, where
9
10 the path splits into different directions. Nodal spaces contain a media item representing
11
12 the artwork (an image, a sound file, a video clip or a text excerpt), which is either a
13
14 digital equivalent of the artwork or some accompanying documentation (e.g., the cover
15
16 of a book, the poster of a film), with connections categorized according to the reference
17
18 archetype. Crossroads serve the function of splitting the chosen category into single
19
20 artwork relations: in graph-like representations, in fact, only one-to-one relations can be
21
22 directly encoded, while many-to-many relations need an intermediate node to connect
23
24 them with each other via a set of one-to-one relations.
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32 Figure 2

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34
35 Figure 2: The template for nodal spaces in Labyrinth 3D: notice the doors and the low
36
37 balustrade in the middle.
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41 Fig. 2 illustrates the basic template for nodal spaces: a low circular balustrade,
42
43 reminiscent of a sacred enclosure, is situated in the middle area, open in several points
44
45 so as to provide an affordance inviting the user to step into the inner part of the space,
46
47 where the artwork (missing in the figure) is situated. The space is surrounded by a wall,
48
49 with doors opening on different pathways. Each nodal space has a fixed number of
50
51 doors: depending of the actual number of categories by which the artwork in the node is
52
53 connected with the other artworks, some doors may be hidden by greenery.
54
55
56

57 The user navigation starts from an artwork, situated in a nodal space: the user
58
59 must choose one of the doors posited on the edge of the node, each labelled after the
60

1
2
3 name of a different category - among the ones acknowledged by the conceptual model
4
5 of the archetype: story, character, object, action, location, and epoch. Pathways are
6
7 symmetric, so they can be walked both ways. The user is free to explore the labyrinth,
8
9 going back to previous locations as many times as she/he wishes. The design of the
10
11 navigation was inspired by the paradigm of *constrained navigation* (Burigat and
12
13 Chittaro 2007), with the aim of making it affordable also to non-expert users of 3D
14
15 applications. This approach constrains the user to move in the 3D space according to
16
17 simple, pre-defined paths and movements - instead of letting her/him move freely in the
18
19 space. Navigation controls are provided by circles of lights posited on the floor, that the
20
21 user clicks to be transported to the exact location of the circle. Smaller circles are
22
23 posited in front of the doors leading to the pathways, and along the pathways. Larger
24
25 circles mark the presence of artworks in the middle of nodal spaces: when one of these
26
27 circles is clicked on, a layer appears where the title of the work and an accompanying
28
29 image are displayed, and a media item can be viewed or played (depending on its type).
30
31 A button labelled "More information" makes a further layer appear, with information
32
33 about the artwork (artist, age and a short text, see Fig. 3). Small circles of light appear
34
35 inside the navigation controls when they are clicked on, so that they can be
36
37 distinguished from the controls that have not been clicked on yet, eventually forming a
38
39 sort of "red thread" that marks the path made by the user so far. The metaphor of the red
40
41 thread, aimed at improving self orientation, is also enforced by a small console, posited
42
43 in the lower part of the screen, that shows the list of the artwork nodes visited by the
44
45 user: by clicking on a node in the list, the user is brought back to that node. The console
46
47 also contains buttons for ending the session and turning off the sound. Notice that,
48
49 differently from standard virtual environments, the interface does not contain a map
50
51 displaying the user position: rather, the orientation is entirely committed to the
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1
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3 navigation controls, as described above, and to the sequence of visited artworks
4
5 reported in the navigation console.
6
7

8 In order to make the experience more engaging and to counterbalance the lack of
9
10 commitment provided by a non-directed navigation, we introduced an explicit element
11
12 of *gamification* in the interaction: when the session begins, the user is challenged to
13
14 reach a "target node" through the archetype traversal. When the user reaches the target
15
16 node, or when he/she decides to exit from the maze, the session ends and the user is
17
18 shown with the statistics about her/his own performance (number of visited nodes,
19
20 elapsed time, backtrackings), which provide an incentive to come back to the
21
22 installation to improve one's own performance.
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28 **4.2 Production**

29
30 Labyrinth 3D was part of a larger project about the use of Semantic Web
31
32 techniques for multimedia publishing, the Labyrinth project, jointly conducted by an
33
34 academic partner, i.e., the research team of the University of (omitted), a media partner,
35
36 i.e., a small publishing company, and a software company; a 3D agency was hired by
37
38 the consortium to develop the application. The project, aimed at creating a web based
39
40 platform for navigating semantically annotated media archives, included both a web
41
42 based, hyper-textual interface, and the 3D interface described here, Labyrinth 3D,
43
44 developed as an app for Mac and Windows. The university team included a project
45
46 manager, a new media expert, an interaction designer, and a knowledge engineer.
47
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51
52 The production workflow assumed by the project addressed a typical scenario of
53
54 the publishing industry. Publishing companies collect huge archives of references and
55
56 media items, sometimes as the result of editorial services, more often aimed as part of
57
58 their content editing workflow (formally described by Hardman et al. 2008). These
59
60 archives represent significant assets of the company since, after they have been

1
2
3 collected, they often become again an input to the editorial processes by inspiring the
4 ideation and development of new editorial products, such as monographs and series.
5
6 Thanks to their availability in digital format, then, they can be seen as potential editorial
7 products themselves. The archive collected by the publishing company for the project
8 concerned the topic of the labyrinth and it included 200 items, selected with the goal of
9 having different media types represented in the archive (text, pictures, sounds and
10 movies). Given the archive, a set of relevant archetypes were identified through the joint
11 work of the publishing professionals and the new media experts, and modelled in a
12 formal ontology: beyond "labyrinth", "hero" and "journey" were chosen for their large
13 spatial and temporal coverage. Finally, the 3D application was designed and developed.
14
15 In September 2014, we conducted an evaluation of Labyrinth 3D, described in the next
16 section.

17
18 The core of the system is the Archetype Ontology (AO), which represents the curatorial
19 view on the archive embedded in the 3D installation. The ontology, designed and
20 formally encoded by the knowledge engineer, contains the representation of a set of
21 archetypes and describes how the artefacts represented in the archive are associated
22 with them via the categories that provide the dimensions of archetype description,
23 namely "story", "character", "object", "action", "location" and "epoch". By the end of
24 the project, the ontology contained 38 stories, 40 characters, 30 actions, 39 locations, 19
25 objects and 40 epochs, distributed over the three archetypes. A description of the
26 ontology can be found in Damiano and Lieto (2013). The process by which the items in
27 the archive are put in relation with the archetypes is conducted in a semi-automatic way,
28 starting from their metadata, following the procedure described by Damiano et al.
29 (2015). The metadata annotation of the archive is conducted via a form-based web
30 interface following a standard metadata schema; when the items in the archive are

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3 uploaded to the system, their metadata are searched for connections to the archetypes by
4
5 automatic reasoning processes. Finally, the set of resulting connections are checked for
6
7 wrong connections and possibly corrected by a human expert. Notice that the reasoning
8
9 process generates not only trivial connections, derived from archetype elements that are
10
11 explicitly mentioned in the metadata of each artefact, but also more subtle connections,
12
13 derived from the inner structure of the archetype conceptual model, such as for
14
15 example, the relation between story and episodes. As a result, a curator may decide to
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17 discard some of the connections found by the automatic reasoning software, but also
18
19 she/he may find unexpected, yet plausible, connections.
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25 The 3D maze is not built statically: rather, it is created step by step while the
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27 user advances through the virtual environment, as the result of her/his choices. So,
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29 during the visit, the maze literary emerges from the archetypes stored in the ontology,
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31 with unpredictable configurations that depend on the interaction with the user and on
32
33 some random elements embedded in the design. For example, when the number of the
34
35 connections for an artefact exceeds a given threshold⁹, a maximum number of
36
37 connections to be displayed are randomly selected. For these reasons, should the user
38
39 use the system in different times, she/he would find her/himself in consistent, yet
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41 different mazes, achieving a new experience every time.
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46 47 ***4.3 Navigation example***

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49 In order to exemplify the functioning of the 3D labyrinth, we resort to a navigation
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51 example, conducted by using the "labyrinth" as the reference archetype (thus doubling
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60 ⁹ Currently set to 7 to comply with the known limitations of working memory (Miller 1956)

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3 the role already covered for the spatial layout). Consider the artwork
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5 “Minotauromachia”, a painting by Pablo Picasso (Figure 3¹⁰).
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11 Figure 3

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13 Figure 3: Start nodal area, Minotauromachia by Pablo Picasso, Spain ("Spagna" in
14 Italian) 1935.
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19 The screenshot in Figure 4 represents the first step of the interaction: the user is
20 positioned in the nodal space that contains the painting and is surrounded by a set of doors.
21
22 The doors represent the categories that connect it with other artworks, as encoded in the
23 ontology. Following the conceptual model of the archetype, each door is labelled after a
24 different category, in order to mark that the artworks reachable through that door share
25 one of more features with the current artwork in the given category (one character, one
26 or more places, two stories, etc.). Pointing and clicking on the small circle posited in
27 front of the door leads the user through a pathway to the next node, which can be a
28 nodal space or a crossroad.
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44 Figure 4

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46 Figure 4: Doors from start nodal space, labelled according to the archetype categories
47 (character or agent, place, epoch) by which it relates to the other artworks.
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52 In Figure 4, a partial view of the start nodal space can be seen, with doors for the
53 "character" category (here, labelled as "agent"), the "location" category (labelled as
54 "place") and the "epoch" category. Taking the door marked as "agent" (character), the
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¹⁰ The metadata of the artworks are in Italian for presentation reasons.

1
2
3 user is brought through a pathway to a crossroad with doors leading to a set of artworks
4 that exhibit the characters of "Theseus" and/or the "Minotaur" (Figure 5). Notice that,
5 since there are more than one artworks displaying the characters engaged in the
6 Minotauromachia (such as, e.g., paintings, ancient coins, etc.), a crossroad is needed to
7 fork the path into several branches to the single artworks, so to maintain the principle
8 "one node, one artwork". From here, if the user chooses the door surmounted by the
9 title "Teseo uccide il Minotauro" (Italian for "Theseus killing the Minotaur", centre of
10 Figure 5), she/he will walk through a pathway to the nodal space which contains the
11 artwork with the same title, i.e., an ancient Greek vase representing Theseus in the act
12 of killing the Minotaur (Figure 6).
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Figure 5

34 Figure 5: Crossroad for the category "character": the titles of the related artworks are
35 written over the doors (in Italian). From left to right: Ancient coins discovered in
36 Cnossos ("monete rinvenute a Cnosso"), Theseus killing the Minotaur ("Teseo uccide il
37 Minotauro"), The frescos of Villa Imperiale in Pompei ("affreschi della Villa Imperiale
38 a Pompei").
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Figure 6

51 Figure 6: A Greek vase depicting Theseus killing the Minotaur, unknown creator
52 ("anonimo"), Greece ("Grecia"), 5th century B.C.
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Backtracking to the initial nodal space (the one containing Picasso's
Minotauromachia) and choosing a different door (i.e., a different category) from this
nodal space, the user can take a different path: for example, by choosing the door

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3 labelled as "objects", i.e., artworks related with the same object as the current artwork
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5 (e.g., Ariadne's ball of thread), the user gets to the crossroad represented in Figure 7:
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7
8 notice, for instance, the door to the 17th century Italian painting entitled "Il filo di
9
10 Arianna" (Italian for "Ariadne and the thread", on the right of Figure 7).
11

12
13 Artwork by artwork, the user makes her/his way through the maze, enjoying the
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15 artworks she/he comes across in a serendipic journey through ages and locations, until
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17 she/he eventually gets to the target, or presses the button "Exit" posited at the bottom of
18
19 the interface. At any time, the user can go back to a previously visited artwork by
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21 clicking on the dots in the bar posited in the navigation console, labeled as "Stations"
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23 (bottom of figures).
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29
30 Figure 7

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32 Figure 7: crossroad for the "object" category (after backtracking to the initial nodal
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34 space, Figure 3) with doors to different artworks. From left to right: Theseus killing the
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36 Minotaur ("Teseo uccide il Minotauro"), Sleeping Ariadne ("Arianna dormiente"),
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38 Ariadne and the thread ("Il filo di Arianna").
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44 The overall path made by the user in the example navigation can be seen in Figure 8.
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49
50 Figure 8

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52 Figure 8: Schema of the user navigation in the example, interleaving nodal spaces and
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54 crossroads.
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5. Meeting the audience

In September 2014, we carried out an evaluation of the Labyrinth 3D, in order to gather information about the users' liking of the application and preferences about its use. In the occasion of a scientific dissemination fair open to the general public, small groups of 3 to 5 people, chosen among the attendants, were given a demo of Labyrinth 3D. After a short introduction to the application, the users were asked to choose a path in the labyrinth from an initial random node, with the experimenter clicking on the navigation controls corresponding to the current user's choices. This procedure was motivated by the fact that, given the high inflow of visitors, we decided to exclude the usability of the interface from the evaluation, in favour of a more coordinated execution of the testing protocol.

The users were generally enthusiastic about the application, with teachers and young adults especially attracted by the potential applications of the virtual environment for didactic and dissemination goals. Users tended to read carefully the information displayed about the single items, reasoning aloud about their connection with the archetype and with the previously visited artworks. Some users explicitly asked to interact directly with the system and were allowed to do it, thus enabling the experimenters to make ethnographic observations about their navigation. The ethnographic observation showed that navigation was generally easy: the users were able to understand the use of the controls (the lit circles posited on the floor) to move from a location to another, with some problems only at pointing at the distantly located circles, which were too small due to the 3D perspective. Some users uttered their bewilderment at finding themselves in a node they had already visited, but were ready to accept the explanation that this is typical of labyrinths.

The preliminary evaluation was conducted on a corpus of 51 media objects, which included images, text excerpts and video clips, described according to 3

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3 archetypes (labyrinth, hero and journey). After each session, users were asked to answer
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5 individually a short written questionnaire in an anonymous form. The questionnaires
6
7 were collected in a separate area by different experimenters.
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10 The questionnaire was designed to test the acceptance of the 3D environment, its
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12 immediacy of use and its appeal for the average media users, in order to assess the
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14 achievement of the design goals of the application, i.e., stimulating the users to navigate
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16 the repository through an engaging experience. Inspired by the notion of participatory
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18 design in heritage (Smith and Iversen 2014), we tested some specific design choices,
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20 such as the setting of the labyrinth and its use for different purposes. To do so, we asked
21
22 the users to express preferences about the appearance and use of the application, aimed
23
24 at gathering information for the design of similar applications within the framework of
25
26 Labyrinth 3D.
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31 The questionnaire included 7 questions. Question 1 grouped 6 sub-questions,
32
33 aimed at investigating the general **acceptance** of the application: by using Likert scales
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35 (with 5 points from -2 to +2, mapped onto values from 1 (-2) to 5 (+2) in the subsequent
36
37 data analysis), we asked testers to what degree the application was:
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39
40

- 41 (1) intuitive
- 42
- 43 (2) interesting
- 44
- 45 (3) engaging
- 46
- 47 (4) useful
- 48
- 49 (5) appealing
- 50
- 51 (6) straightforward to use
- 52
- 53
- 54
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56
57 Then, through multiple answer questions, we asked the testers to indicate their preferred
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59 devices (Question 2) for using the application (tablet, pc, smartphone, etc.) and to
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indicate what use (Question 3) they envisaged for the application (teaching,

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3 entertainment, cultural dissemination, etc.). In order to investigate how the users
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5 perceived the application, we also asked the testers what types of applications were
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7 similar to the proposed application (Question 4), with alternatives ranging from didactic
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9 media (encyclopaedia) to cultural dissemination (museum) to entertainment (video
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11 games). Finally, we asked some specific questions about the acceptance of the metaphor
12
13 of the labyrinth and of the visual design. In particular, we asked the testers (Question 5)
14
15 to select adjectives to describe the 3D labyrinth (with positive and negative polarities:
16
17 "confusing", "intriguing", "ordinary", "challenging", "playful" and "unpleasant"), then
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19 we asked them whether they liked or disliked the proposed setting, ancient ruins
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21 (Question 6), and what alternative settings they would like to have implemented
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23 (Question 7) through multiple choices that proposed a range of locations typically
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25 associated with cultural heritage: historical palace, modern building, museum building,
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27 etc.
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34 41 testers took part in the evaluation, males and females, with ages ranging from
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36 10 to 67 years old. The results were encouraging under all perspectives, i.e. the
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38 acceptance of the application, its immediacy of use, the understanding of the metaphor
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40 of the labyrinth and the suitability of the setting. The average value of the answers to the
41
42 questions concerning the acceptance was 4.5 (Question 1, subquestions i to vi, all 5
43
44 point Likert scales), with "interesting" as the highest average value (4.7) and
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46 "straightforward" as the lowest average value (4.32), indicating that the application was
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48 appealing but its use was not entirely clear, an indication for future redesign. The
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50 average values collected for Question 1 are illustrated in Table 1.
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55 The remaining questions revealed further details about the users' perception of
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57 the application for what concerns its goals and uses. As for the preferred device for
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59 using the application, the "PC" was the most frequently selected choice (25 users),
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3 followed by “tablet” (17) and “smart phone” (17), indicating the wish of taking
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5 advantage of the navigation experience in a separate session from other activities,
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7 through a device that fosters immersion. As for intended use (Question 3) “cultural
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9 enrichment” was the most frequently selected choice (31 users), followed by “teaching”
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11 (18 users). The “video game” and the “encyclopaedia” (Question 4), were not
12
13 surprisingly the most frequently selected choices (18 and 14 users) of similar
14
15 applications - since Labyrinth 3D was designed with the goal to disseminate cultural
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17 contents with an immersive, game-like interaction style in mind. The labyrinth
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19 environment (Question 5) was perceived as “intriguing” by 31 users, but “challenging”
20
21 or “playful” only by 13 of them, showing that only a few users perceived it as overtly
22
23 arduous or tended to catch only its playful side. Finally, most users (31, 75.6%) liked
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25 the proposed setting. The most preferred alternative settings (Question 7, multiple
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27 choice) were the museum and the library (15 users each), in line with the reception of
28
29 the content as cultural indicated by the answers to Questions 3 and 4.
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36 The results described above, although influenced by the fact that the testers were
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38 selected among the users who showed more interest about the application by
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40 approaching the demo booth, show a good acceptance of the installation and of the
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42 design choices and goals underlying it. In particular, the users seemed to perceive the
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44 application as a tool for teaching cultural notions to self (cultural enrichment) or others
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46 (school teaching) and find it similar to video games, but they don't perceive the
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48 entertainment as primary (since this option was selected only by 9 participants). As
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50 confirmed by the ethnographic observation, these results reveal a strong interest for the
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52 installation, which, prompted by the language of 3D, extends also to the cultural
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54 contents to embrace the goal of cultural dissemination.
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6. Conclusion

This paper has proposed the use of 3D graphics for designing novel tools of exploratory search in cultural heritage archives. The tool is an online virtual environment where the user can navigate the meaning relations over the items in the archive. Targeted at cultural heritage, the application Labyrinth 3D employs the cultural archetypes to inform the conceptualization of the archive and the creation of the traversal paths, engaging the user in the exploration of the archive.

The use of 3D graphics in cultural heritage is usually aimed at the visualization of objects and locations, existing or reconstructed, as a support to study and dissemination activities. Relevant examples span from private initiatives (such as, the well known Google Art Project¹¹ and Arounder¹²) to public research and educational projects (see, e.g., the animated 3D reconstructions of the ancient city of Rome and of Roman villas described by Dylla et al. 2008 and Rua and Alvito 2011). These approaches are characterized by the use of visualization for reconstructing locations and objects that do not exist anymore, or for superimposing to existing locations and objects new interactive functionalities, making them available to users in a remote modality.

The work presented in this paper radically departs from this approach and differentiates from the works mentioned above since, in our approach, the 3D representation is not employed to reconstruct real environments, but as a tool to convey meaning relations through a visual environment. The works surveyed above focus on the modelling and reconstruction of real environments, while we see the virtual environment as an experienceable substitute for the relations over the objects in an external domain, represented by the media archive, gathered and organized into a set of

¹¹ www.google.com/culturalinstitute/project/art-project

¹² www.arounder.com

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3 cultural archetypes. In our approach, the user is immersed in a virtual, maze-like
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5 environment that embeds a cultural heritage archive, where she/he actively explores the
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7 archetypal meaning of the items in the archive, finding her/his way through the archive
8
9 in a personal way.
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12 Labyrinth 3D relies on the assumption that the use of shared conceptual models,
13
14 the cultural archetypes formally encoded in the system as computational ontologies,
15
16 together with the pleasure of exploration and enactment brought by the (itself
17
18 archetypal) environment, can work in favour of the user engagement. We have
19
20 illustrated the inspiration and goals that informed the design and implementation of the
21
22 system, bringing a creative component into the user experience, acknowledged by the
23
24 positive impact on the audience.
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29 On the edge of the transition of the Web to the paradigm of Linked Open Data,
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31 which makes the need for generalized access models to networked contents even
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33 stronger, the scalability of the system, which relies on formal ontologies and automated
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35 reasoning, confirm its innovation potential for the design of novel access tools to
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37 cultural heritage archives that literally bring the user into the core of the archive.
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Tables

Table 1: The liking of the application by the users, through Likert scales (values 1 to 5)

SYSTEM PROPERTY	AVERAGE VALUE	STANDARD DEVIATION
intuitive	4.35	0.72
interesting	4.7	0.57
engaging	4.41	0.74
useful	4.48	0.61
appealing	4.5	0.74
straightforward	4.32	0.68

Figures

Figure 1: *Pathosformeln* from Warburg's *Builderatlas* (www.engramma.it).

Figure 2: The template for nodal spaces in Labyrinth 3D: notice the doors and the low balustrade in the middle.

Figure 3: Start nodal area, *Minotauromachia* by Pablo Picasso, Spain ("Spagna" in Italian), 1935.

Figure 4: Doors from start nodal space, labeled according to the archetype categories (character or agent, place, epoch) by which it relates to the other artworks.

Figure 5: Crossroad for the category "character": the titles of the related artworks are written over the doors (in Italian). From left to right: Ancient coins discovered in Cnossos ("monete rinvenute a Cnosso"), Theseus killing the Minotaur ("Teseo uccide il Minotauro"), Frescos from Villa Imperiale in Pompei ("affreschi della Villa Imperiale a Pompei").

Figure 6: The Greek vase depicting Theseus killing the Minotaur, unknown creator ("anonimo"), Greece ("Grecia"), 5th century B.C.

Figure 7: crossroad for the "object" category (after backtracking to the initial nodal space, Figure 3) with doors to different artworks. From left to right: Theseus killing the Minotaur ("Teseo uccide il Minotauro"), Sleeping Ariadne ("Arianna dormiente"), Ariadne and the thread ("Il filo di Arianna").

Figure 8: Schema of the user navigation in the example, interleaving nodal spaces and crossroads.

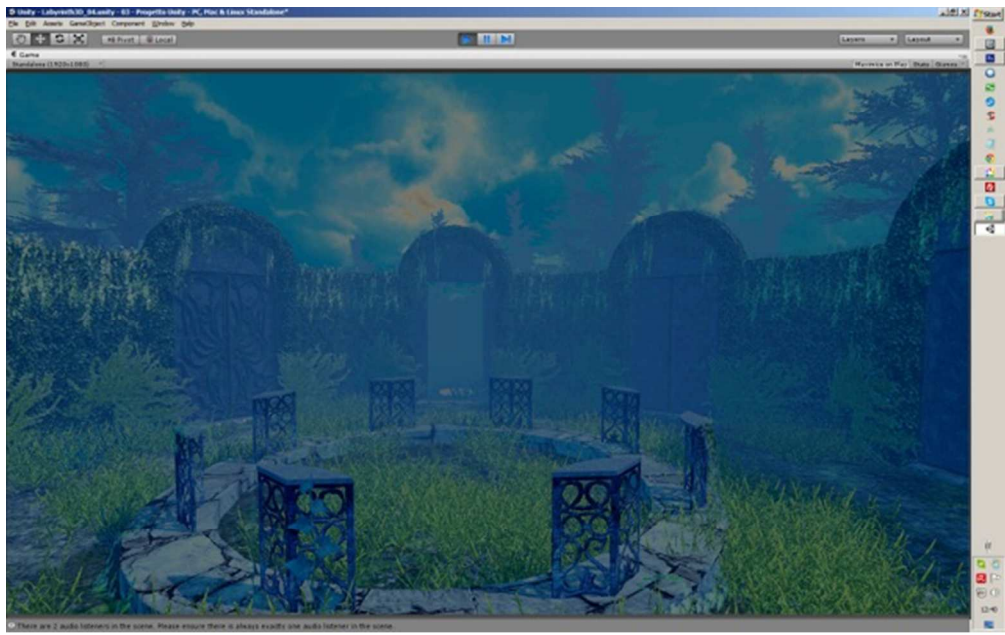
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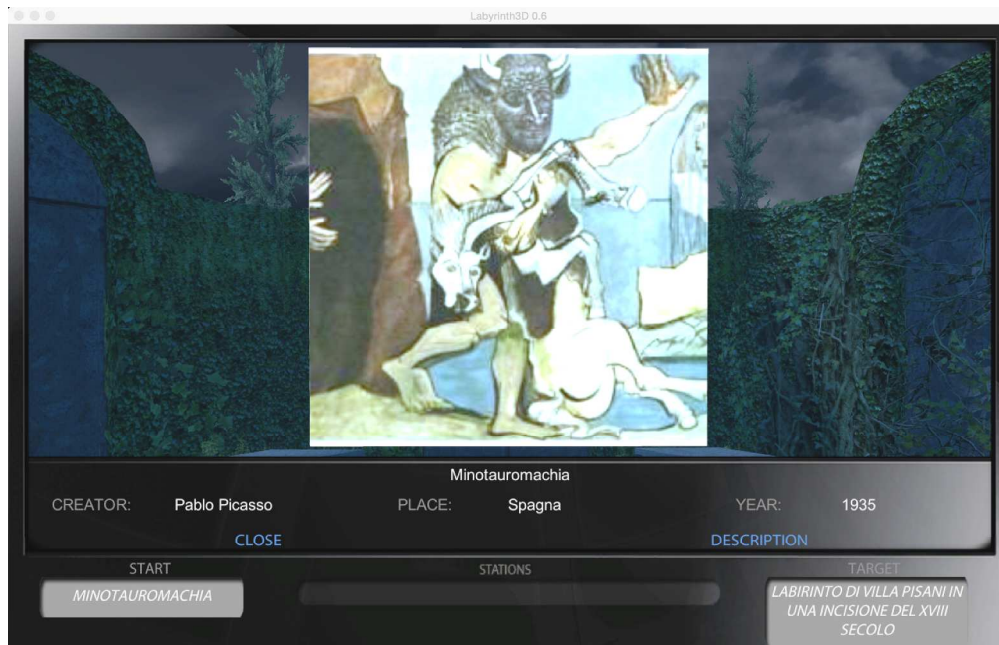
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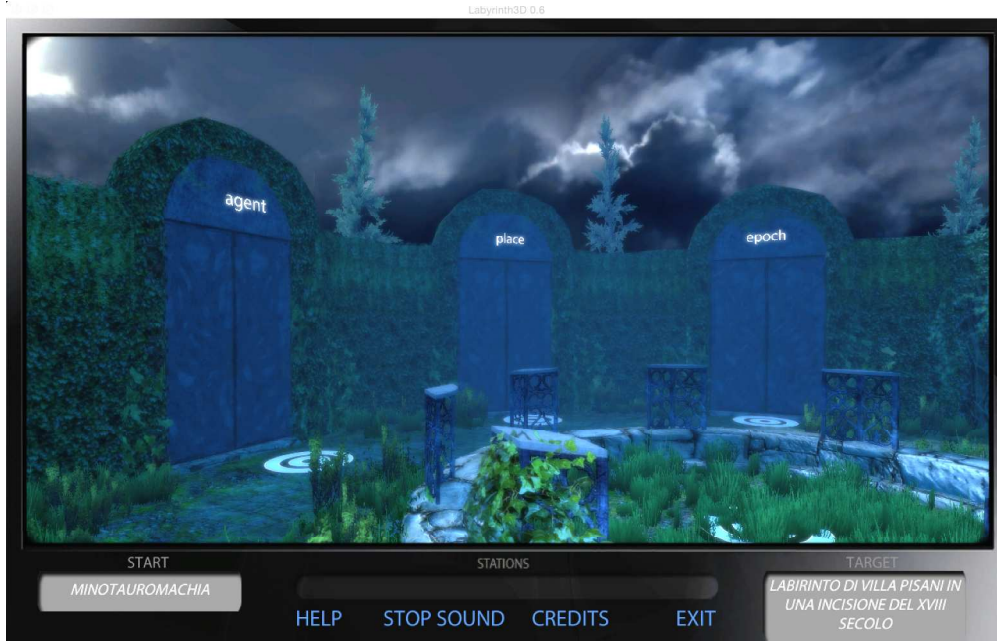
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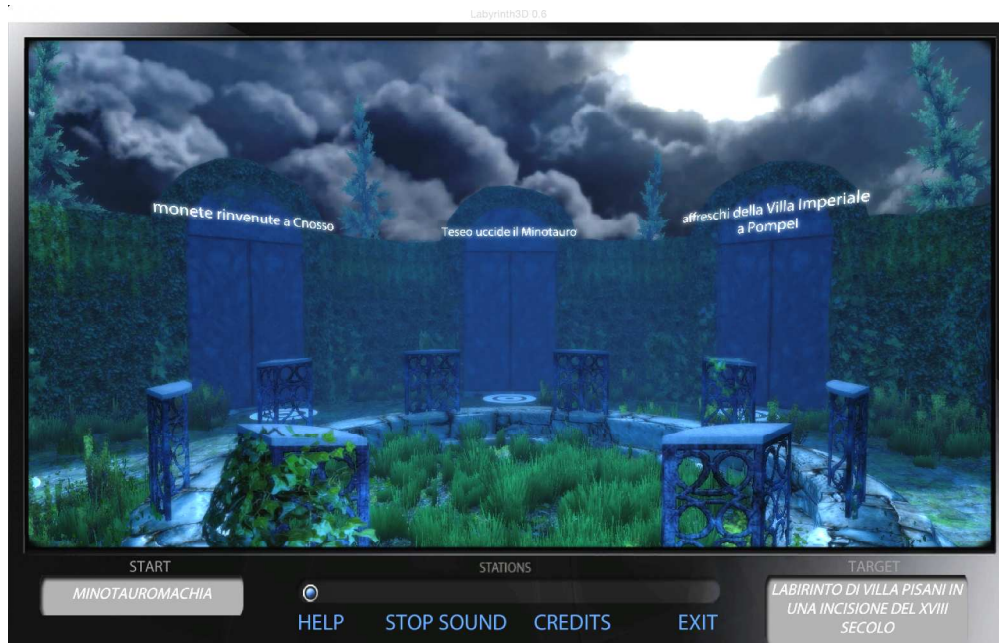
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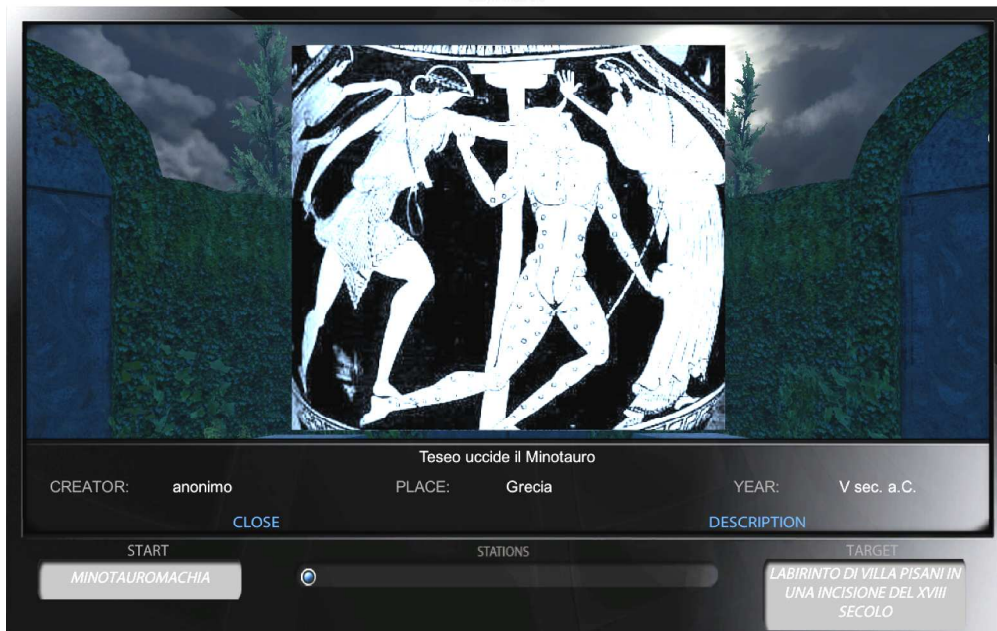
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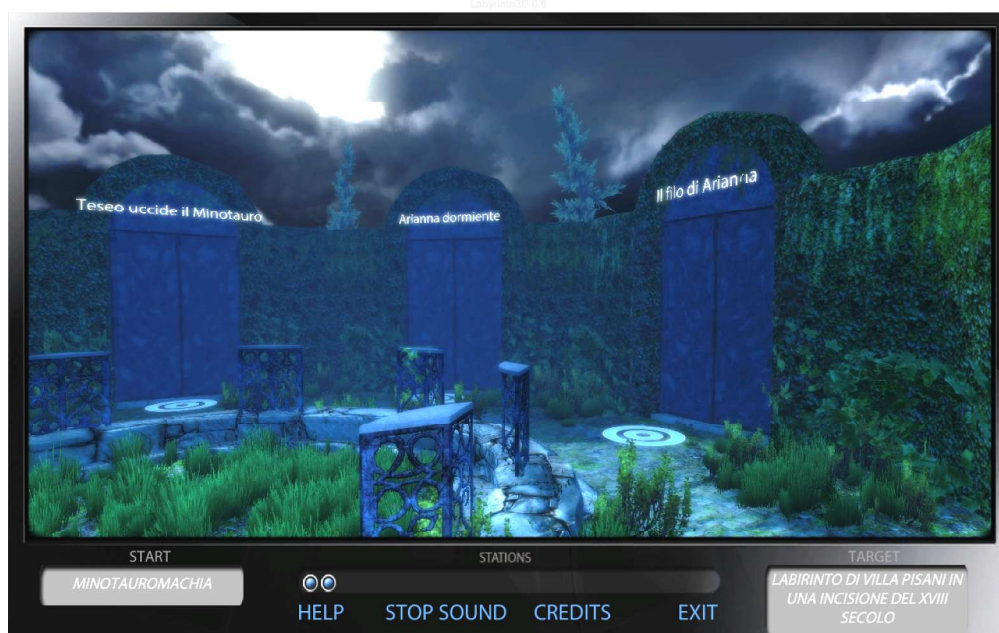
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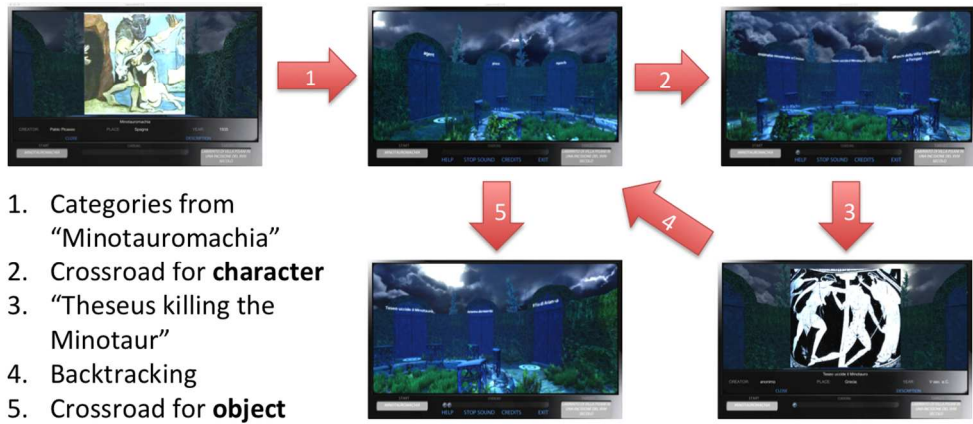
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